AD-A124 096 APP FY-80 TASK I AND II REPORT(U) NAVAL OCEAN RESEARCH AND DEVELOPMENT ACTIVITY NSTL STATION MS E HASHIMOTO 30 SEP 80 NORDA-TN-69 1/2

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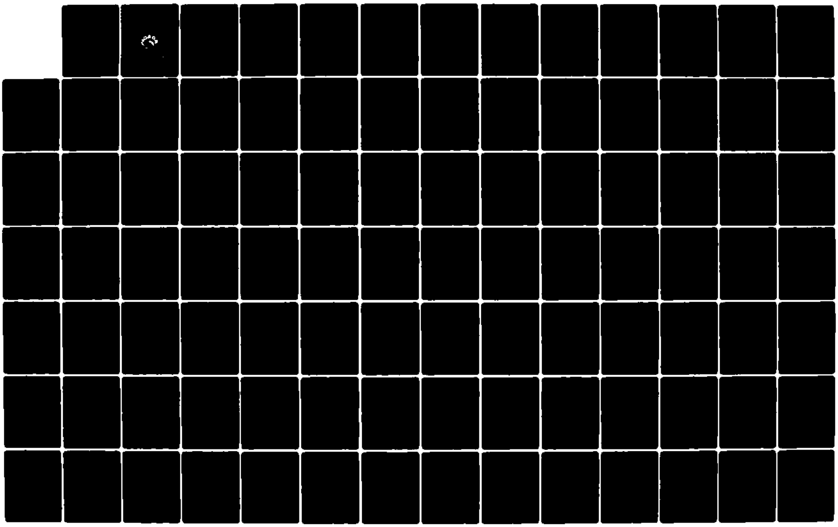

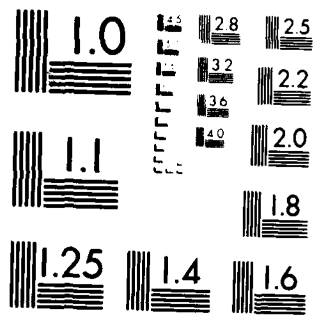
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2.8
3.2
3.6
4.0

5

NORDA Technical Note 69

Naval Ocean Research and
Development Activity
NSTL Station, Mississippi 39529

APP FY-80 Task I and II Report

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September 1980

APP FY-80 TASK I and II REPORT

PART (I)

"Comparisons of Vertical Sound Speed Profiles from the SIMAS and ICAPS Environmental Data Bases with High Quality CTD and STD data."

and

PART (II)

"Evaluation of the SIMAS and ICAPS Environmental Data Bases, Data Handling Procedures and Merge Methodology"

by

E. HASHIMOTO

30 September 1980

RE: Classified References, Distribution Unlimited
No change per Mr. Carl Mueller, NORDA/ Code 125L

ABSTRACT

This report consists of two major parts. Each part addresses different problems or issues. Part I is titled, "Comparison of "on-board" In-situ Vertical Sound Speed Profiles from the SIMAS and ICAPS Environmental Data Bases with High Quality CTD and STD Data", APP FY-80 Task #I. The purpose of Part I was to compare the SIMAS and ICAPS sound speed profiles with sound speed profiles from assumed oceanography (CTD or STD observations).

Part II is titled, "Evaluation of the SIMAS and ICAPS Environmental Data Bases, Data Handling Procedures, and Merge Methodology", APP FY-80 Task #II. The purpose of Part II was to compare and recommend the data bases, algorithms, merge techniques of either SIMAS or ICAPS. The major causes for the "significant" differences in the SIMAS vs. ICAPS sound speed comparisons were found to be in the merge methodologies and historical environmental profiles.

RECOMMENDATIONS

Based on the findings of Part I and II of this report, the following recommendations are forwarded:

- Philosophy

  - *Recommend that the ICAPS philosophy of reliance on the in-situ BT profile be adopted. In SIMAS, there appears to be far too much reliance on the integrity of its fixed, historical sound speed profiles. This heavy reliance on a fixed sound speed profile and a fixed criteria can lead to problems when operating is known physically dynamic ocean regions where the zones themselves meander and migrate horizontal, as well as, vertical distances.*

- In-situ BT data handling

  - *Recommend that the ICAPS procedure (inputting of only observed pairs of depth-temperature pairs) be adopted as an "interim" procedure. The SIMAS procedures of inputting 7-9 inflection points (G. Brown) by use of a straight-edge to line up data points, and then picking off and using as input the numerical values where the straight lines intersect leads to inputting depth and temperature values which may have never been recorded.*

  - *Recommend that APP favorably encourage any ongoing efforts to inputting not selected data points from a in-situ BT profile, but the inputting of the in-situ BT trace through a continuous recording procedure. This will eliminate the variable-inconsistent human factor of incorrect selections of inflection points along a BT trace.*

- Historical Environmental Data Base

  - *Recommend that the ICAPS historical temperature and salinity data base be adopted on an interim basis.*

  - *Recommend two alternatives to replace or modify the present ICAPS historical data bases:*

(a) *When available, replace the ICAPS temperature, salinity files with the temperature, salinity, density and sound velocity analyzed data sets from the Generalized Digital Environmental Model (GDEM) by Dr. T. Davis, (NOO-022).*

(b) *Using recent deep XBT data (as available) update the archival temperature file, particularly in the region of the deep sound channel.*

- Develop a more appropriate procedure to insure that the proper depth of the layer depths are properly specified (i.e., replacing the present procedure of manual interpretation and inputting of the *in-situ* temperature data with an automated procedure which utilizes and inputs the entire trace or profile taken).
- Recommend a more appropriate representation of the depth of the deep sound channel axis be developed.
- Additional Recommendations
  - *Recommend that the bathymetry files in ICAPS be replaced by the automated SYNBAPS (Synthetic Bathymetric Profiling System).*

ACKNOWLEDGEMENTS

The author would like to express his appreciation towards certain individuals who have been associated with or assisted in segments of this study. Without the cooperation of these individuals, this study could not have been completed. Very special appreciation to Dr. A. L. Anderson (NORDA 320), Dr. J. A. Davis and Mr. R. Lauer (both with NORDA 321) for providing invaluable technical guidance, to LCDR A. Galus (NORDA 530) for providing funding support, to Mr. J. Schumacher (ODSI), Mr. G. Kerr and Mrs. C. Parker (both of NORDA 320) for providing support in the preparation of this report.

PART I

"Comparisons of Vertical Sound Speed Profiles predicted from the SIMAS and ICAPS Environmental Data Bases with High Quality CTD and STD data".

I. INTRODUCTION

The SIMAS (Sonar In-situ Mode Assessment System) and ICAPS (Integrated Command Anti-submarine warfare Prediction System) programs address different system applications but are similar in that each has been developed for use as an "on-board" prediction system. It is known that SIMAS and ICAPS do not employ identical environmental data bases. The extent to which these data bases differ is being addressed in a separate study. The purpose of this particular study was to:

- compare predicted SIMAS and ICAPS vertical sound speed profiles with observed, measured and recorded *in-situ* CTD (Continuous-Temperature-Depth) or STD (Salinity-Temperature-Depth) data.
- present, whenever possible, similarities or dissimilarities between the predicted SIMAS and the ICAPS sound speed profiles with the CTD and STD data.
- discuss the implications of these similarities and dissimilarities.
- compare the "goodness" of SIMAS and ICAPS to the "Assumed Oceanography".

Since this study was of limited scope it focused entirely on vertical sound speed profile comparisons. Reliable, processed CTD or STD data available to study was (17) records. Figure 1 presents the geographical locations of the test cases.

In an earlier study entitled, "Comparison of the ICAPS and SIMAS Historical Environmental Data Bases" by E. Hashimoto, NORDA 321, FY-79 APP Task II Report, dated 28 September 1979, the author compared vertical sound speed profiles from the SIMAS and ICAPS environmental data bases using XBT (expendable bathythermograph) data as input. It also presented "significant" differences found between the two environmental data bases. That report, which described the selection procedures of appropriate SIMAS and ICAPS historical sound speed profile, is being published as a NORDA Technical Memo #66 titled, "Comparisons of Historical and *in-situ* Vertical Sound Speed Profiles from the SIMAS and ICAPS Environmental Data Bases".

In the present study, SIMAS and ICAPS simulations of vertical sound speed profiles using the STD temperature data are compared to the measured sound speed profiles or profiles calculated by Wilson's equation.

Footnote: Comparison of bottom loss provinces and bottom loss versus grazing angle curves used by SIMAS and ICAPS were also conducted by the author. At 18 sites, ICAPS and SIMAS results were compared; bottom loss provinces were compared in the Mediterranean Sea. The results of this study are contained in NORDA Technical Note No. 71.

II. APPROACH USED IN STUDY

The approach used in this comparison study was to obtain and establish a set of test case profiles using measured ocean environmental data with which the predicted SIMAS and ICAPS sound speed profiles could both be compared. The test case profile data are from reliable CTD and STD observations. The CTD and STD observations are considered in this study as being the "assumed" or real oceanography. CTD and STD test cases were selected so as to avoid biasing the results towards any given system. The selections were made on the reliability (author's confidence in the observations) and availability (accessible in appropriate format to impact this study) of CTD and STD data.

Both CTD and STD probes have an accurate temperature sensor. The STD also measures salinity. The values of temperature from both sensors are recorded during the observation period. The literature generally states that the relative accuracy of the CTD is approximately $\pm$ 0.005^{o}C for temperature. The STD has a relative temperature accuracy of $\pm$ 0.02^{o}C, a relative salinity accuracy of $\pm$ 0.02 parts per thousand.

Identical measured values of temperature from either the CTD or STD were used as input data for both SIMAS and ICAPS sound speed calculation programs and treated as if the values were those taken by *in-situ* XBTs. Vertical sound speed profiles were obtained from both systems. The SIMAS and ICAPS generated profiles were plotted together with the values of sound speed either measured (by the CTD), or calculated from Wilson's equation (for the STD). The intent for such plots was to illustrate the similarity between the SIMAS or ICAPS vertical sound speed profiles and the "assumed oceanography".

The designations used and the locations of the *in-situ* test cases are tabulated in Table I. The sources for the CTD and STD test cases are identified in Table II.

III. COMPARISONS

In this section the results of the various comparisons are presented along with supporting information. In the simulated comparisons of predicted SIMAS and ICAPS produced sound speed profiles with "assumed" oceanography, similarities and dissimilarities were found with the CTD and STD results (termed "assumed oceanography" in table XV).

In some cases, similarities and dissimilarities appear to be, more or less, consistent or reoccurring. In other cases, they appear unique in their occurence. Presented, are the generalized similarities and major dissimilarities found when comparing the predicted SIMAS and ICAPS profiles with the assumed oceanography. The similarities and dissimilarities are indicated in the appropriate sections to follow.

- All temperature and salinity data from CTD and STD units were sent to NUSC and NAVOCEANO, for SIMAS and ICAPS processing, respectively.

  Naval Underwater Systems Center (NUSC)
  Naval Oceanographic Office (NOO)

- Results were returned to NORDA where they were plotted.
- The accuracy and correctness of all plots were triple checked to eliminate possible errors which may have resulted from (interpreting) reading the data sheets, key punching, unit conversion, or from plotting of incorrect data files.
- All profiles were generated by personnel at NUSC-New London, CT (for SIMAS) and NOO-Bay St. Louis, MS (for ICAPS).
- All "on-board" input data into SIMAS and ICAPS were identical *in-situ* temperature profiles recorded by the CTD and STD temperature sensors.
- Comparisons for similarity and/or dissimilarities in sound speeds ($\overrightarrow{SS}$) were conducted for values:

  $\overrightarrow{SS}$, at the surface (Table III)
  $\overrightarrow{SS}$, at the layer (SSL) (Table IV)
  $\overrightarrow{SS}$, at 1000 feet (SS1000) (Table V)
  $\overrightarrow{SS}$, at the sound channel axis (SSCA) (Table VI)

- Comparisons for similarity and or dissimilarities in depth (D) were conducted for values:

  D, at the layer (in feet) (DLD) (Table VII)

  D, at the depth of the sound channel axis (in feet) (DSCA) (Table VIII)

Figures 2-18 contain comparisons of vertical sound speed profiles which were generated from the SIMAS (dashed lines), and ICAPS (dotted lines) environmental data bases, and the in-situ CTD/STD (both as solid lines) observations.

Tables (IX), (X), (XI), (XII), (XIII), and (XV) present qualitative differences in sound speeds at the surface, at the layer, at 1000 feet, at the channel axis, in the depth of the layer and the channel axis, respectively. Table (XV) contains the numerical values of sound speeds computed from CTD and STD sensors. Table (XVI) contains the numerical values of sound speed computed from SIMAS. Table (XVII) contains the numerical values of sound speed computed from ICAPS.

V. SUMMARY OF THE COMPARISONS

As stated in the introduction, the purpose of this study was to compare predicted SIMAS and ICAPS sound speed profiles with (actual) CTD or STD data (considered as the "assumed oceanography"), to present the similarities or dissimilarities, and to discuss any implication of such similarities or dissimilarities for certain test cases.

Tabulations of the numerical qualitative term and quantitative terms for $\vec{SS}$ at the surface, at the layer, at 1000 feet, at the deep sound channel axis, at the depth of the layer, and at the deep sound channel axis were presented on tables (III thru VIII). There were certain similarities and dissimilarities which appear more frequently than others. Tables (IX thru XIV) are presented in an attempt to simplify these similarities and dissimilarities. The author, for SIMAS and ICAPS and the "assumed oceanography", has made comparisons of the values in sound speed (in ft/sec) at the surface, depth of the layer, at 1000 feet, and at the deep sound channel axis. Comparisons were made between (a) ICAPS and SIMAS predicted results with (b) measured sound speeds from CTD or sound speed calculations from Wilson's equation from STD measurements. A brief summary of these tables (IX) through (XIV) are as follows:

<u>For Sound Speed Profile Comparison In Sound Speeds</u>

- at the surface (17 test case comparisons):

  <u>"none to slight" differences:</u>
  ICAPS = 14 cases
  SIMAS = 2 cases

  <u>"1 f/s <SS <7 f/s" differences:</u>
  ICAPS = 3 cases
  SIMAS = 7 cases

  <u>"7 f/s <SS* <20 f/s" differences:</u>
  ICAPS = 0 cases
  SIMAS = 6 cases

  <u>"20 f/s <SS** <40 f/s"</u>
  ICAPS = 0 cases
  SIMAS = 2 cases

- at the layer, (SSL) (14 test case comparisons)

  <u>"none to slight" differences:</u>
  ICAPS = 14 cases
  SIMAS = 2 cases

  <u>"1 f/s <SSL <7f/s" differences:</u>
  ICAPS = 3 cases
  SIMAS = 7 cases

"7 f/s< SSL*< 20 f/s" differences:
ICAPS = 0 cases
SIMAS = 6 cases

"20 f/s< SSL**< 40 f/s" differences:
ICAPS = 0 cases
SIMAS = 2 cases

- in sound speeds at the channel axis out of 17 test cases:

"none to slight" differences:
ICAPS = 3 cases
SIMAS = 0 cases

"1 f/s< SSCA< 3 f/s" differences:
ICAPS = 4 cases
SIMAS = 2 cases

"3 f/s< SSCA*< 7 f/s" differences:
ICAPS = 2 cases
SIMAS = 5 cases

"7 f/s< SSCA**< 12 f/s" differences:
ICAPS = 5 cases
SIMAS = 4 cases

"12 f/s< SSCA***< 20 f/s" differences:
ICAPS = 0 cases
SIMAS = 0 cases

"20 f/s< SSCA****" differences:
ICAPS = 0 cases
SIMAS = 3 cases

- in sound speeds at 1000 feet out of 17 test cases:

"none to slight" differences:
ICAPS = 10 cases
SIMAS = 0 cases

"1 f/s< SS1000< 6 f/s" differences:
ICAPS = 5 cases
SIMAS = 7 cases

"6 f/s< SS1000*< 12 f/s" differences:
ICAPS = 2 cases
SIMAS = 3 cases

"12 f/s< SS1000**< 20 f/s" differences:
ICAPS = 0 cases
SIMAS = 4 cases

"20 f/s< SS1000***< 75 f/s" differences:
ICAPS = 0 cases
SIMAS = 0 cases

"75 f/s< SS1000****< 100 f/s" differences:
ICAPS = 0 cases
SIMAS = 2 cases

"100 f/s< SS1000*****" differences:
ICAPS = 0 cases
SIMAS = 1 case

In Depth

- in the depth of the layer out of 17 cases:

  "none to slight" differences:
  ICAPS = 3 cases
  SIMAS = 3 cases

  "2 feet < DLD < 30 feet" differences:
  ICAPS = 9 cases
  SIMAS = 8 cases

  "30 feet < DLD* < 90 feet" differences:
  ICAPS = 3 cases
  SIMAS = 4 cases

  "90 feet < DLD** < 150 feet" differences:
  ICAPS = 1 case
  SIMAS = 0 cases

  "150 feet < DLD*** < 250 feet" differences:
  ICAPS = 1 case
  SIMAS = 0 cases

  "250 feet < DLD****" differences:
  ICAPS = 0 cases
  SIMAS = 2 cases

- *in the depth of the primary sound channel axis, out of 14 test cases:*

  "less than 300 feet" differences:
  ICAPS = 7 cases
  SIMAS = 6 cases

  "300 feet < DSCA* < 600 feet" differences:
  ICAPS = 3 cases
  SIMAS = 2 cases

  "600 feet < DSCA** < 1200 feet" differences:
  ICAPS = 4 cases
  SIMAS = 2 cases

  "1200 feet < DSCA*** < 2000 feet" differences:
  ICAPS = 0 cases
  SIMAS = 3 cases

  "2000 feet < DSCA****" differences:
  ICAPS = 0 cases
  SIMAS = 1 case

- ICAPS utilized the CTD/STD input temperature data above 1000 feet more than SIMAS.
- The "rejection" of *in-situ* temperature information in SIMAS is clearly too restrictive. The consequent use of archival information results in large discrepancies with CTD/STD results.

VI. CONCLUSIONS

In the previous study (NORDA TM No. 66) which compared the SIMAS and ICAPS Historical and *INSITU* Environmental Data Bases vertical sound speed profiles and presented "significant" differences, there was no comparisons made with real *INSITU* measurements. In this study, this has been conducted to test for "goodness" and the results are presented.

Upon review of the comparison plots and the tables of similarities and dissimilarities, it is clear that ICAPS demonstrates a noteable superiority to SIMAS in its ability to predict measured sound speed from an "XBT" obtained from CTD or STD data. This does not imply, however, that ICAPS does not need improvement as will be discussed under recommendations.

The authors conclusions based on tables (III through VIII) and (IX through XIV) are as follows:

- "Assumed oceanography" was reproduced more closer by ICAPS.
- Sound speeds at the surface were reproduced more closer in the North Atlantic and North Pacific Oceans by ICAPS.

ICAPS reflects a significantly larger quantity (14 out of 17) of cases where the values of sound speeds at the surface agree (< 1 f/s) closely with the CTD/STD observations than SIMAS (2 out of 17).

Where ICAPS has zero cases, SIMAS showed 8 out of 17 cases where the values of sound speed at the surface differ between either 7 to 20 f/s, or 20 to 40 f/s.

- Sound speeds at the layer were reproduced more closer in the North Atlantic, North Pacific and Indian Oceans by ICAPS.

ICAPS reflects a significantly larger quantity (14 out of 17) of cases where the values of sound speeds at the layer agree (< 1 f/s) closely with the CTD/STD observations than SIMAS (2 out of 17).

Where ICAPS has zero cases, SIMAS showed 8 out of 17 cases where the values of sound speed at the layer differ between either 7 to 20 f/s, or 20 to 40 f/s.

- Sound speeds at 1000 feet were reproduced more closer in the North Atlantic Ocean by ICAPS.

  ICAPS reflects a significantly larger quantity (10 out of 17) of cases where the values of sound speeds at 1000 feet agree (<1f/s) closer with the CTD/STD observations than SIMAS (0 out of 17). SIMAS showed 7 cases to be greater than 12 f/s at 1000 feet of which 3 of this 7 are greater than 75 f/s. ICAPS on the other hand shows all of its values at 1000 feet not exceeding 12 f/s.

- Neither ICAPS nor SIMAS were impressive in their handling of sound speeds at the sound channel axis.

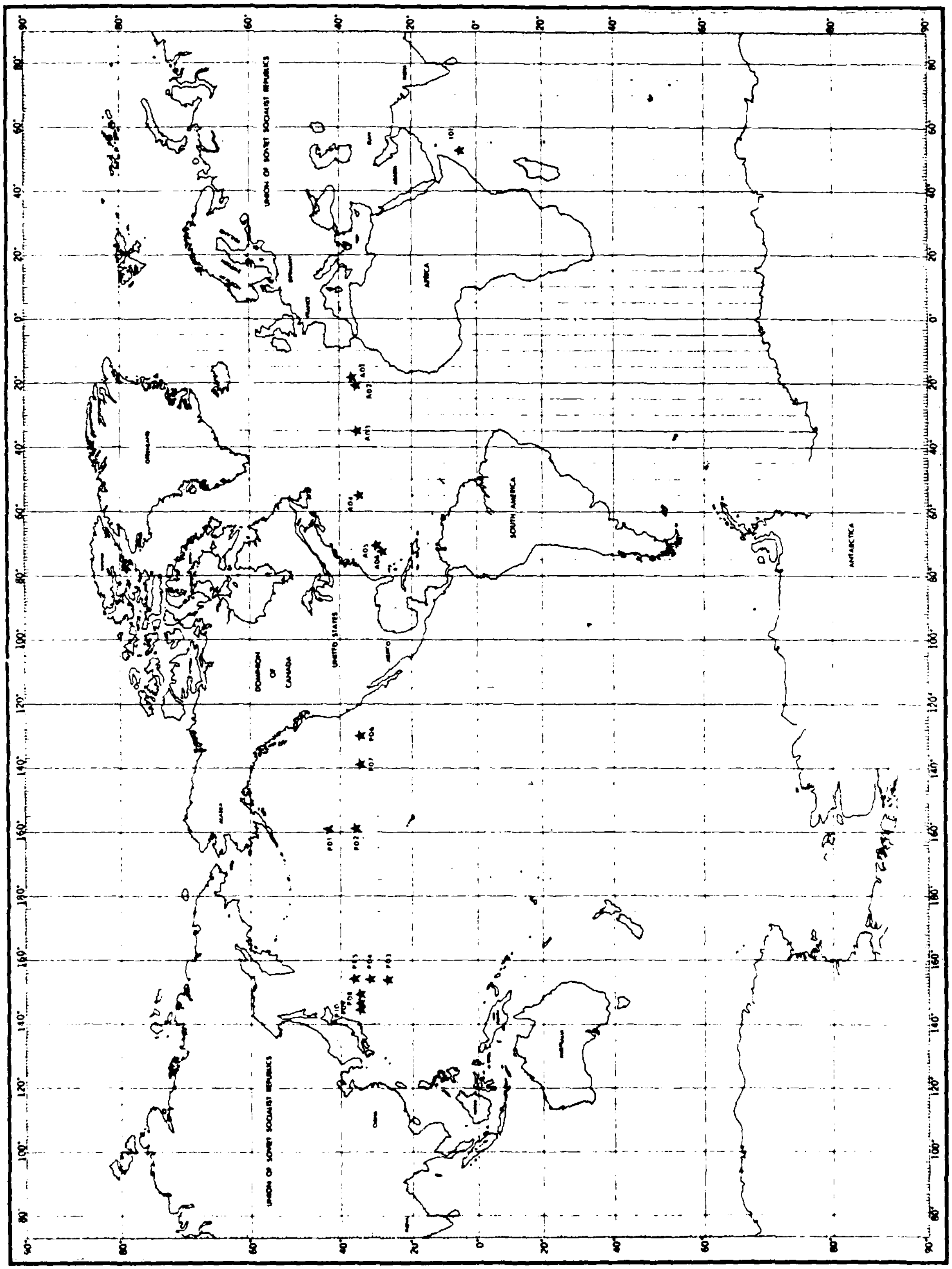
  ICAPS showed that in 9 out of 17 cases, the values of sound speed at the axis were <7 f/s and SIMAS showed 7 out of 17 were <7 f/s. SIMAS showed 3 cases to be >20 f/s at the channel axis, and ICAPS had none.

- Neither ICAPS nor SIMAS were impressive in their handling of the depth of the layer.

  ICAPS showed the depth of the layers to differ between 2 to 30 feet in 9 out of 17 cases and SIMAS shows the depth of the layers to differ between 2 to 30 feet in 8 out of 17 cases.

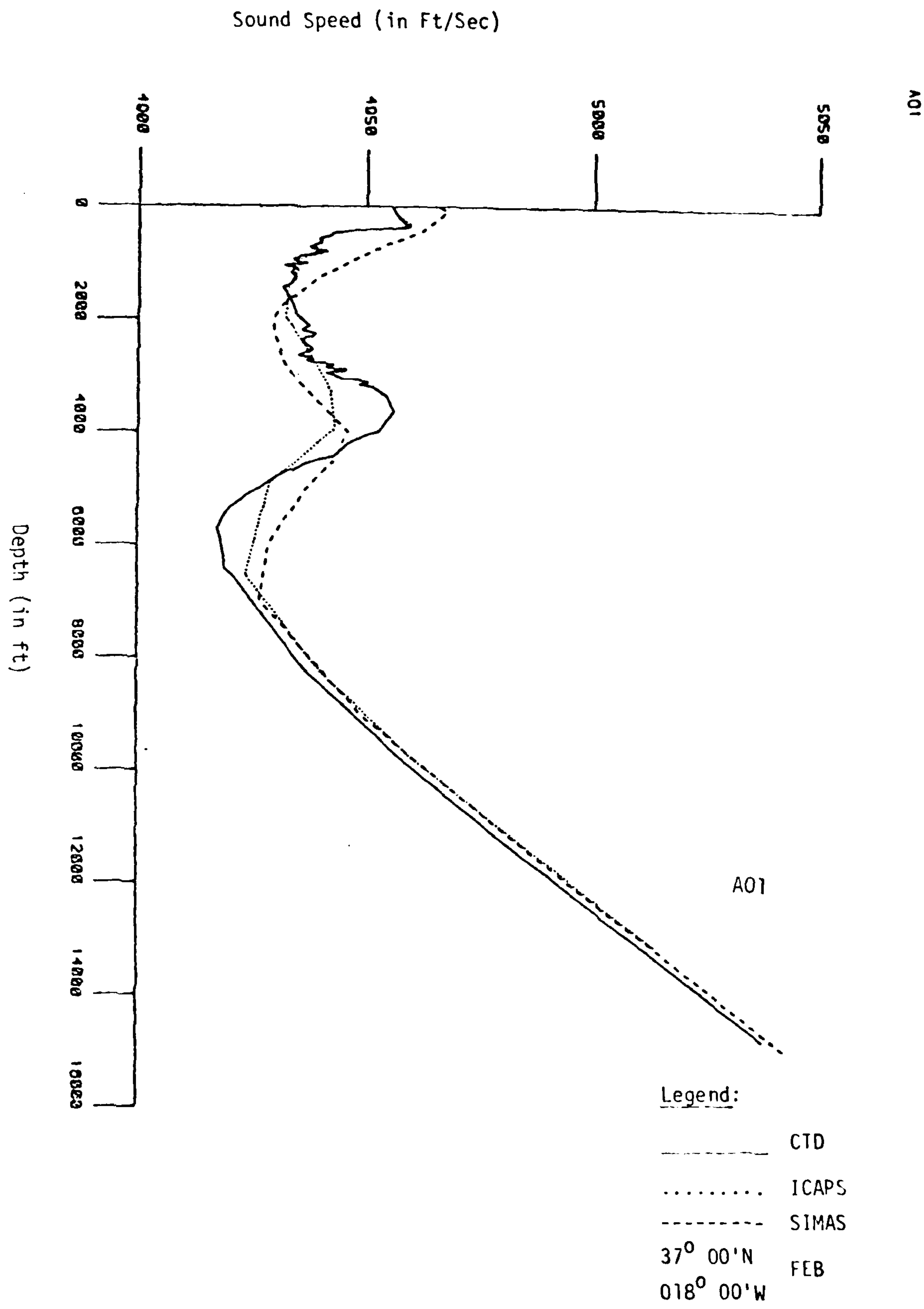
- Neither ICAPS nor SIMAS were impressive in their handling of the depth of the sound channel axis.

  ICAPS showed the depth of the sound channel axis to differ between 0 - 300 feet in 7 out of 14 cases, and SIMAS showed it in 6 out of 14 cases. ICAPS showed the depth of the sound channel axis to differ by <u>greater than 600 feet</u> in 4 out of 14 cases and SIMAS showed it in 6 out of 14 cases.



GEOGRAPHICAL LOCATIONS OF THE SITES FOR COMPARISON

Fig. (1)



Sound Speed (in Ft/Sec)
A01
Depth (in ft)
A01
Legend:
CTD
ICAPS
SIMAS
37° 00'N
018° 00'W
FEB

Fig. 2

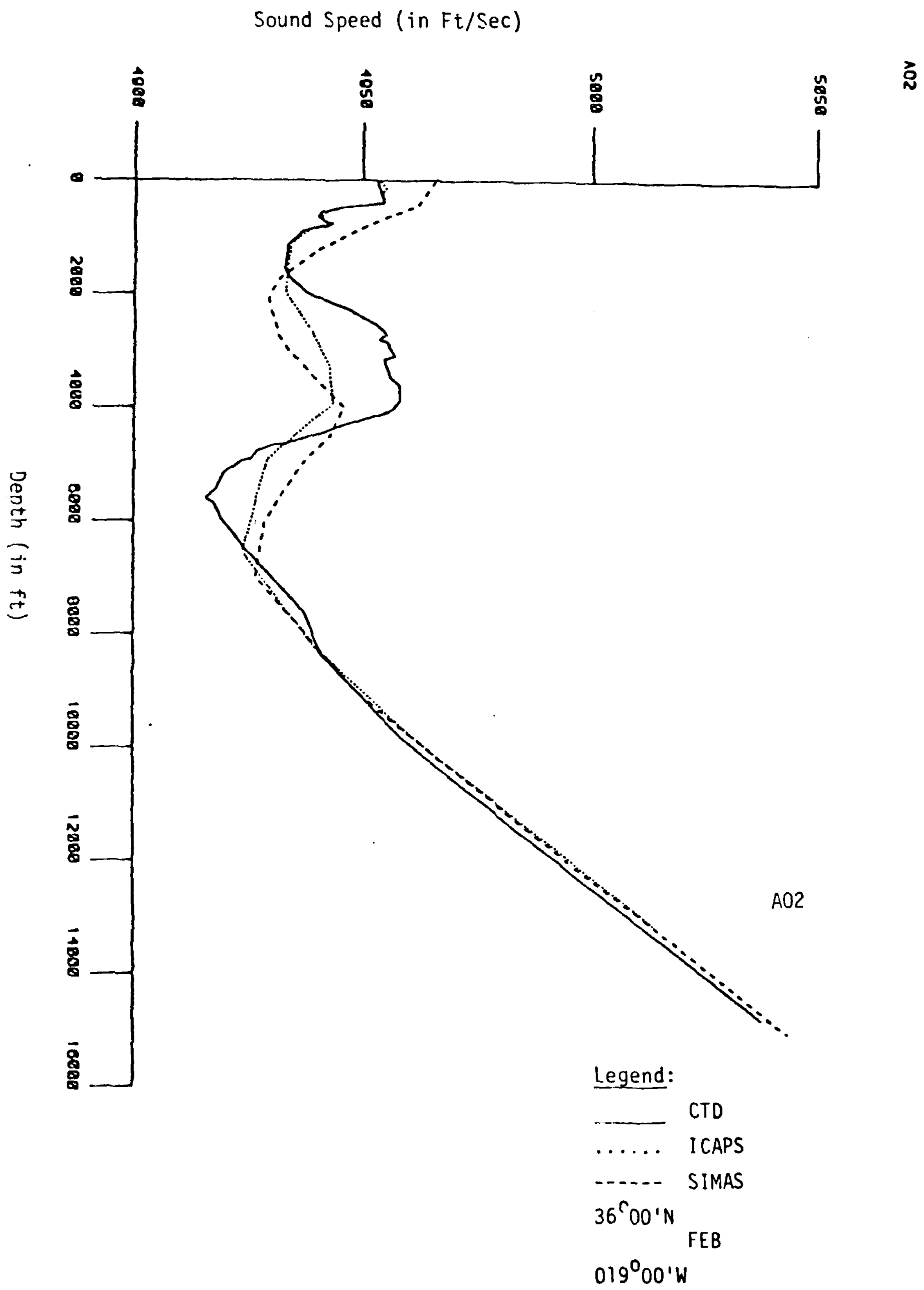

Sound Speed (in Ft/Sec)
5000
5050
A02
Depth (in ft)
0
2000
4000
6000
8000
10000
12000
14000
16000
A02
Legend:
CTD
ICAPS
SIMAS
36°00'N
FEB
019°00'W

Fig. 3

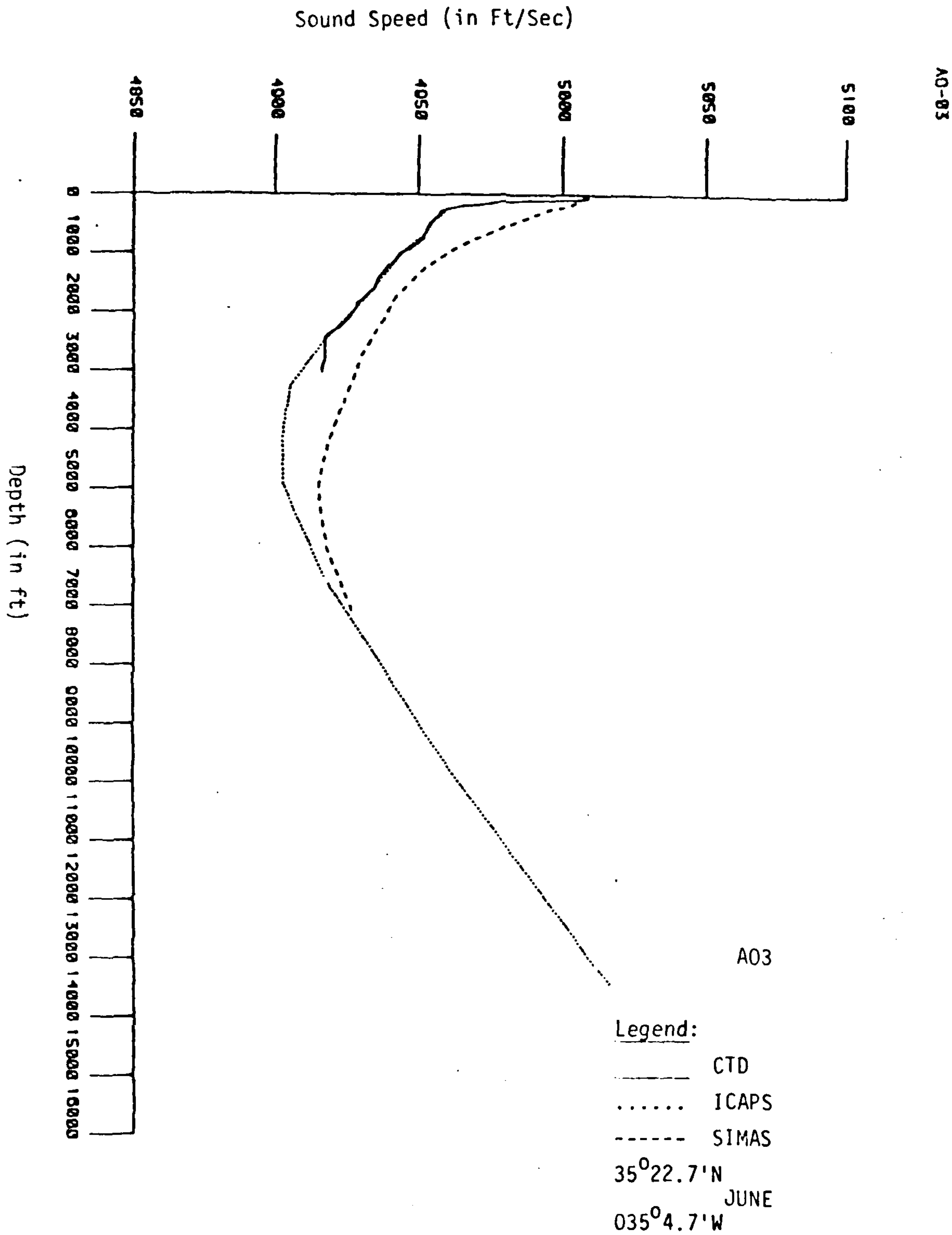
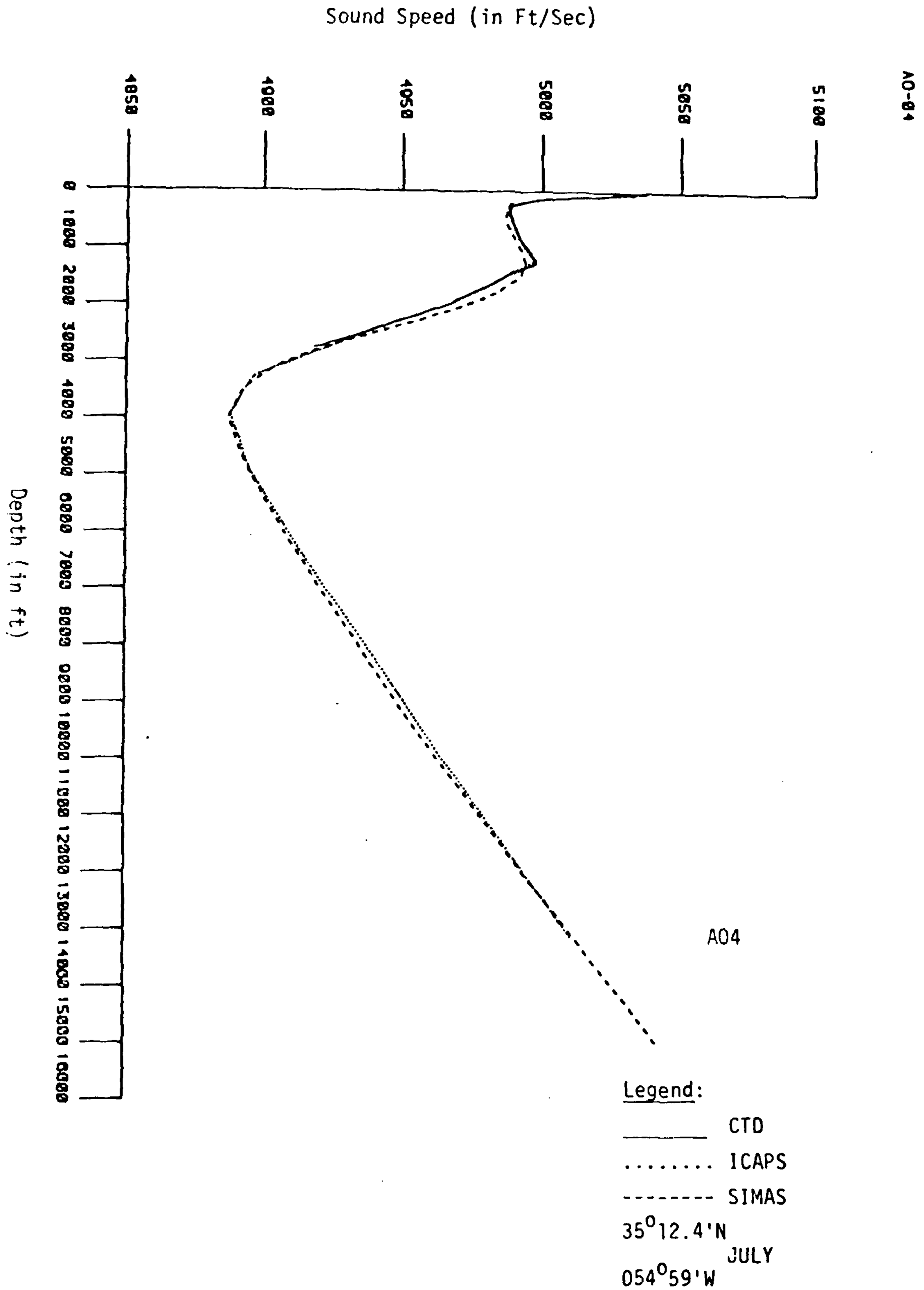

Sound Speed (in Ft/Sec)
4850
4900
4950
5000
5050
5100
AO-03
Depth (in ft)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
15000
16000
A03
Legend:
CTD
ICAPS
SIMAS
35°22.7'N
JUNE
035°4.7'W

Fig. 4


Sound Speed (in Ft/Sec)
Depth (in ft)
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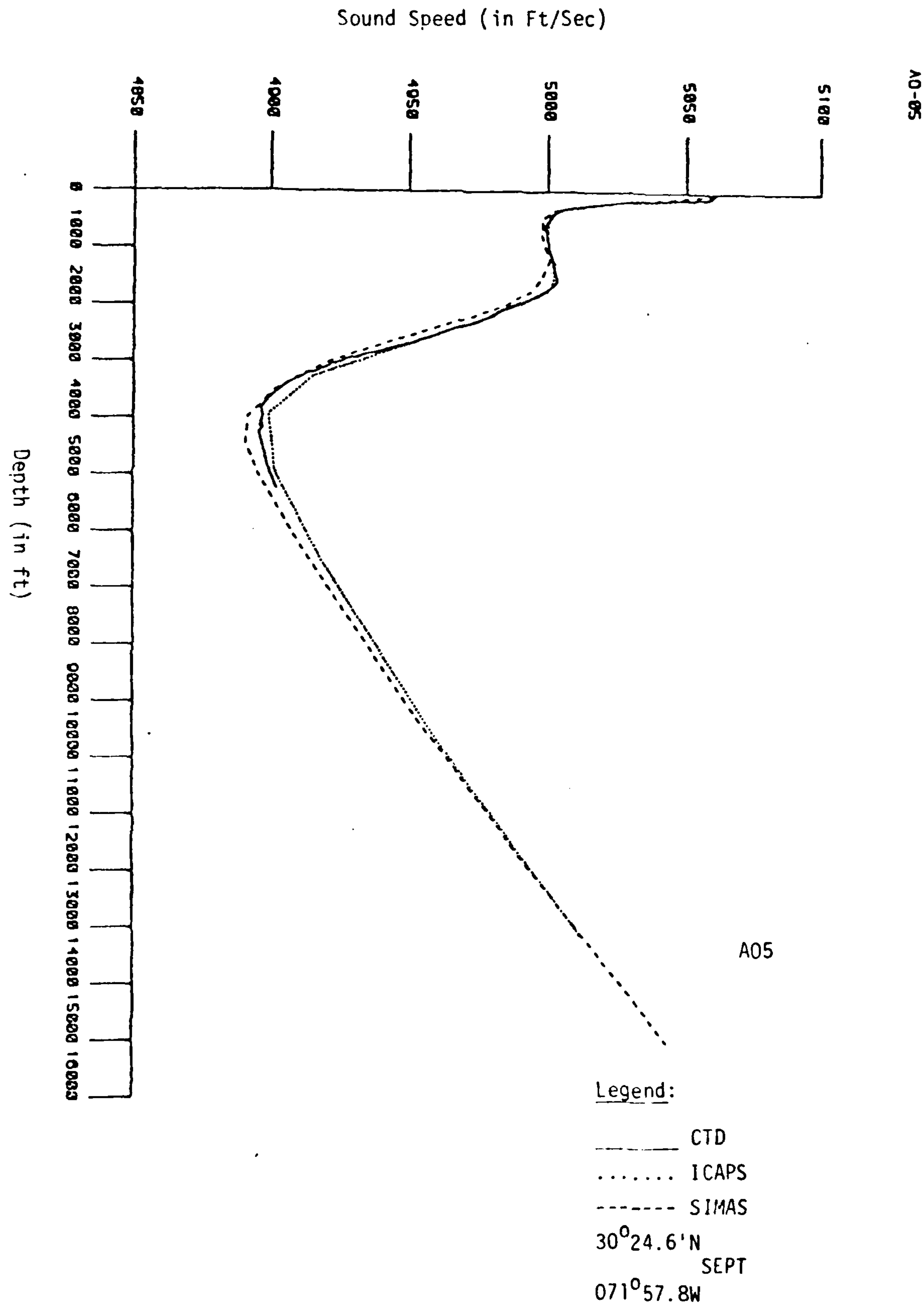
A04
Legend:
CTD
ICAPS
SIMAS
35°12.4'N
054°59'W
JULY

Fig. 5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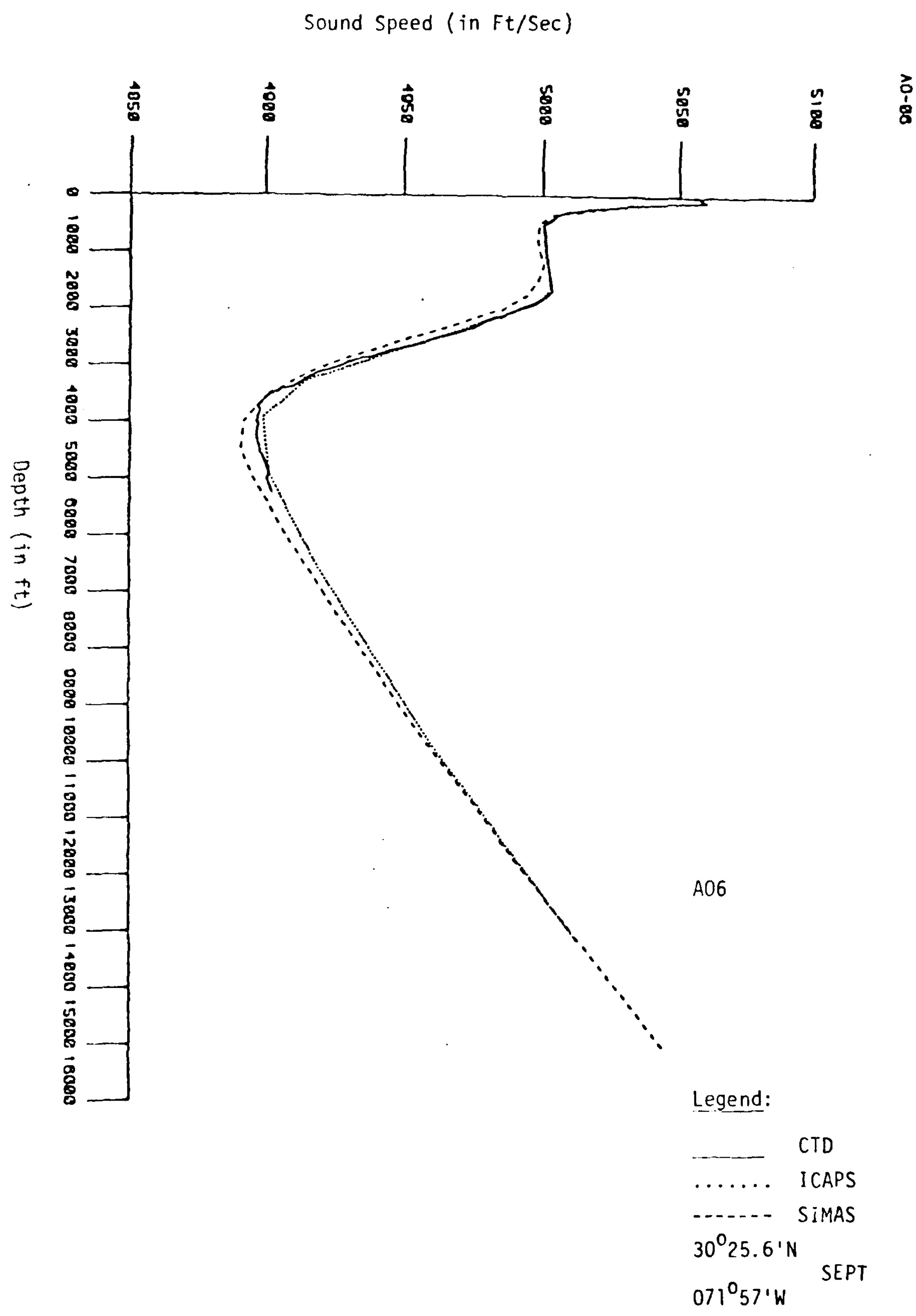
4900
4950
5000
5050
5100
AO-05
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
15000
16000
Depth (in ft)
A05
Legend:
CTD
ICAPS
SIMAS
30°24.6'N
SEPT
071°57.8W

Fig. 6



Sound Speed (in Ft/Sec)
Depth (in ft)
A06
Legend:
CTD
ICAPS
SIMAS
30°25.6'N
SEPT
071°57'W

Fig. 7

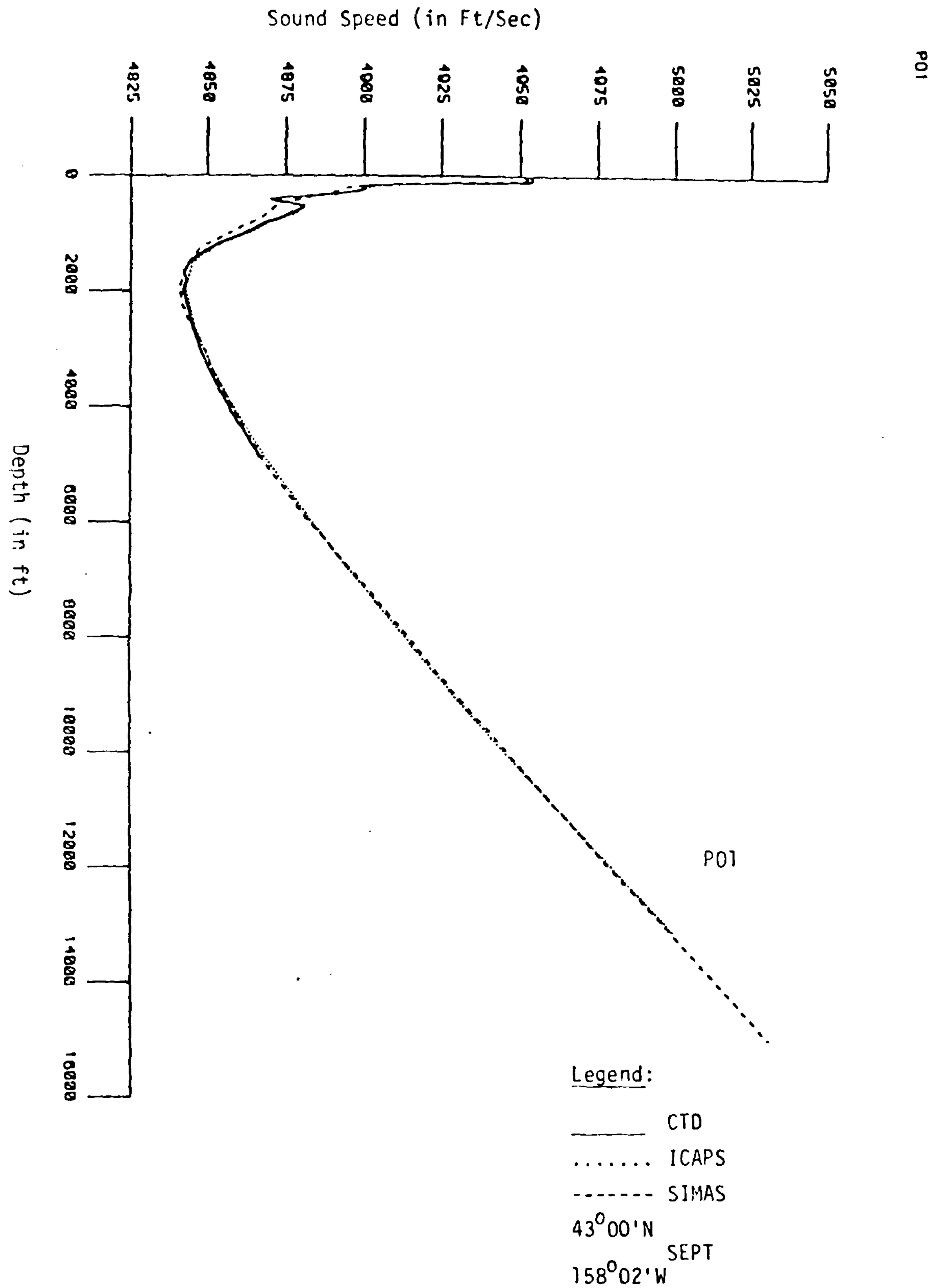

Sound Speed (in Ft/Sec)
4825
4850
4875
4900
4925
4950
4975
5000
5025
5050
P01
0
2000
4000
6000
8000
10000
12000
14000
16000
Depth (in ft)
P01
Legend:
CTD
ICAPS
SIMAS
43°00'N
SEPT
158°02'W

Fig. 8

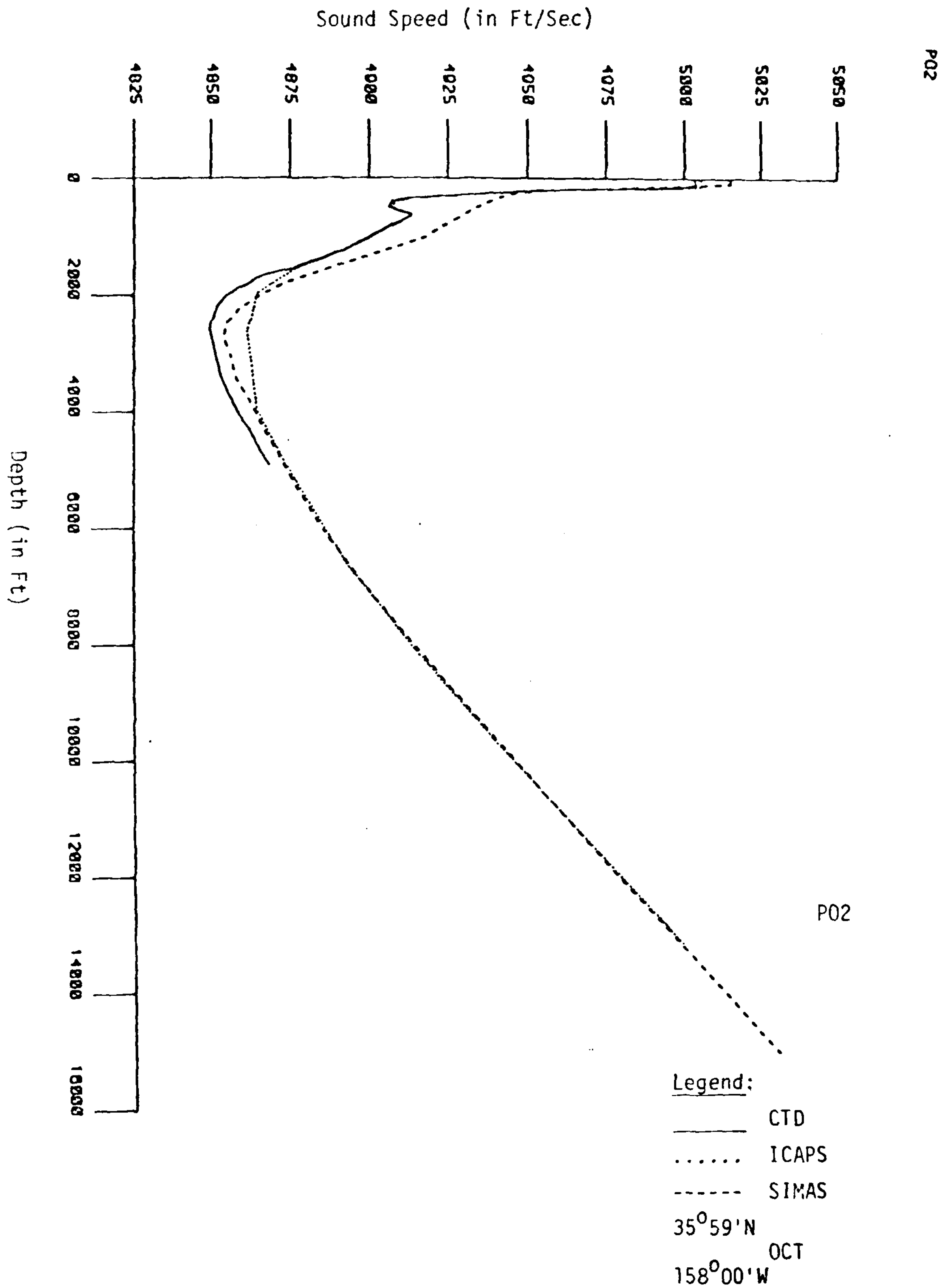

Sound Speed (in Ft/Sec)
4825
4850
4875
4900
4925
4950
4975
5000
5025
5050
P02
Depth (in Ft)
0
2000
4000
6000
8000
10000
12000
14000
16000
P02
Legend:
CTD
ICAPS
SIMAS
35°59'N
OCT
158°00'W

Fig. 9

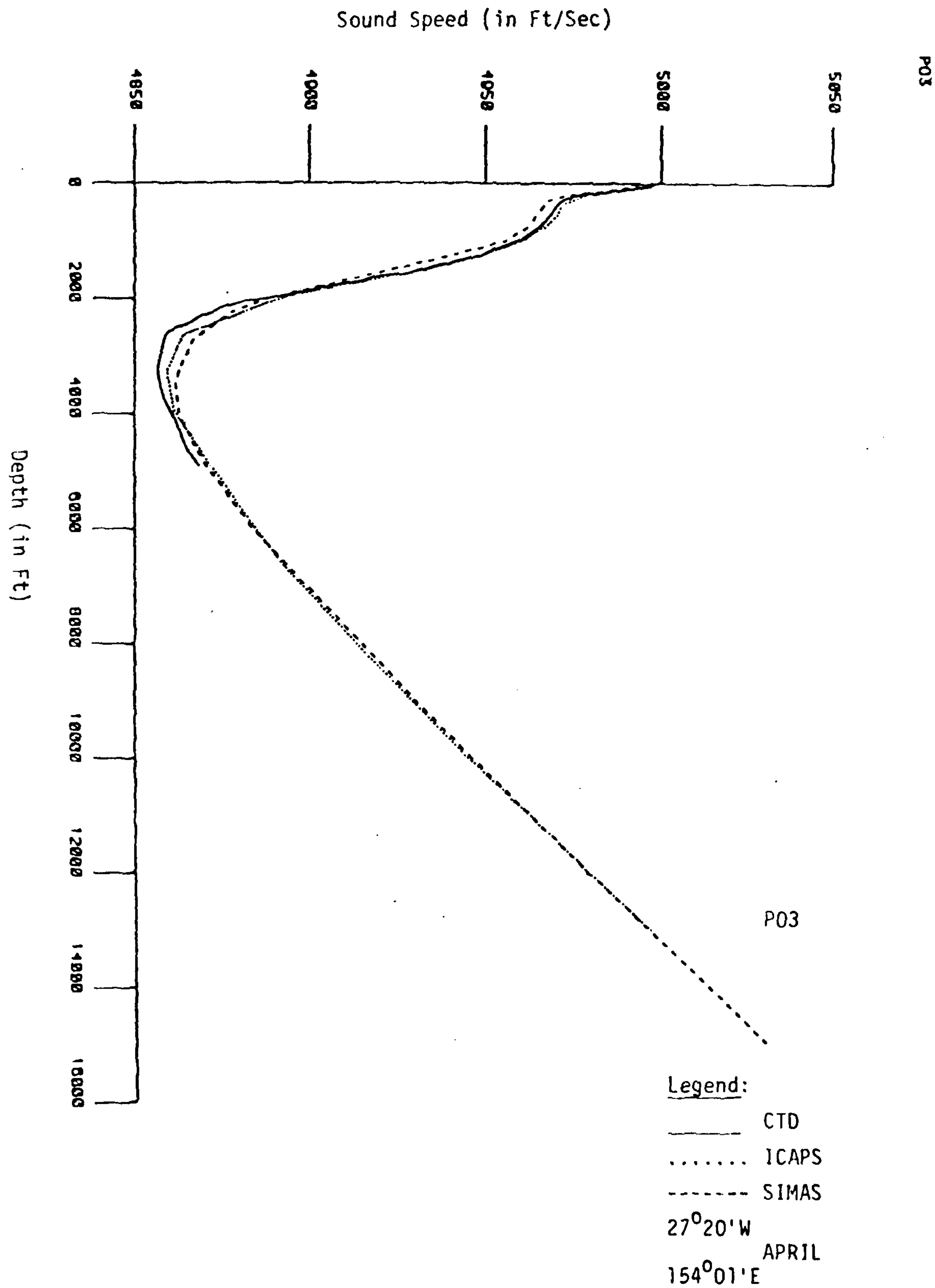

Sound Speed (in Ft/Sec)
4850
4900
4950
5000
5050
P03
Depth (in Ft)
0
2000
4000
6000
8000
10000
12000
14000
16000
P03
Legend:
CTD
ICAPS
SIMAS
27°20'W
APRIL
154°01'E

Fig. 10

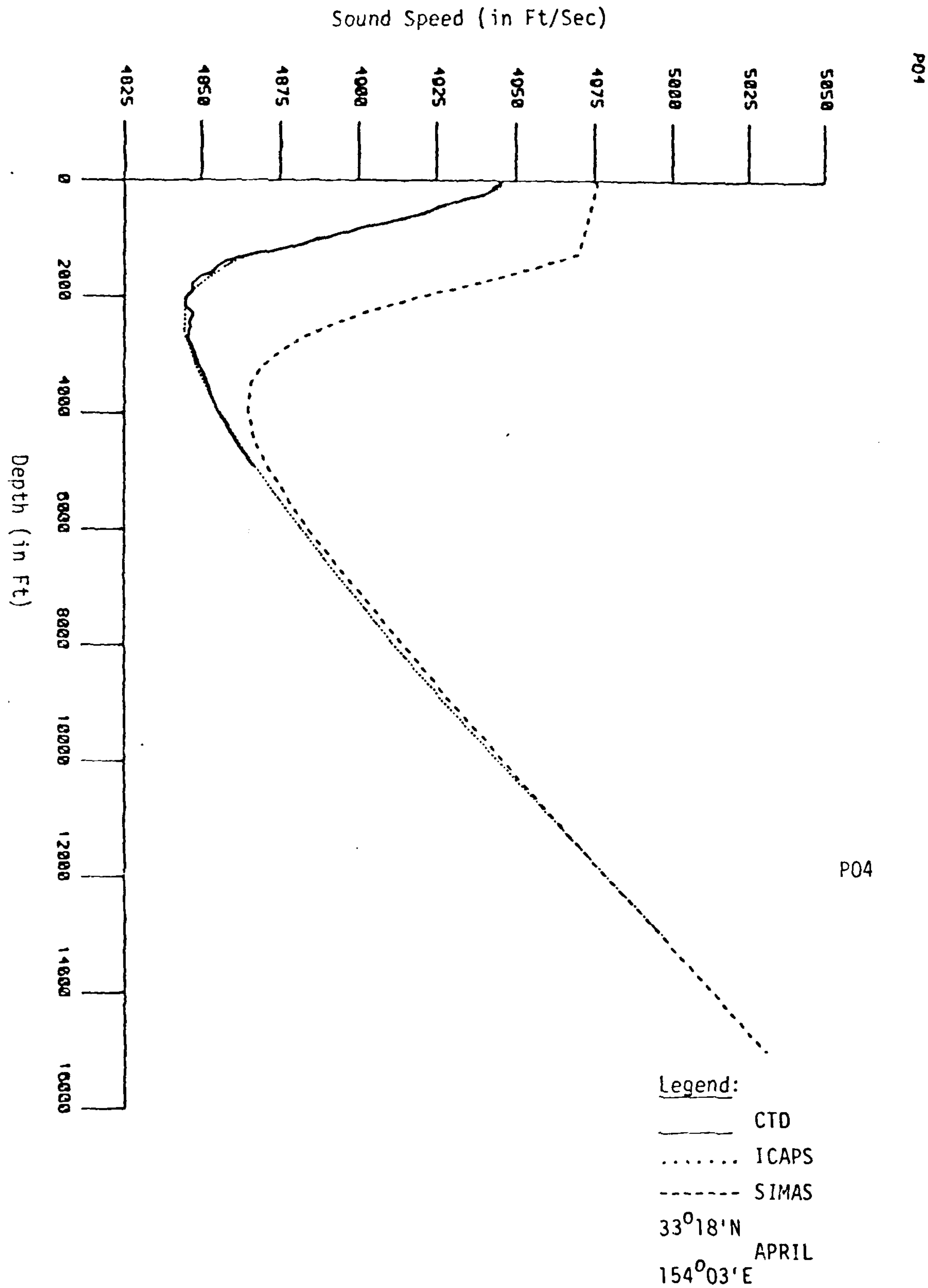

Sound Speed (in Ft/Sec)
4825
4850
4875
4900
4925
4950
4975
5000
5025
5050
P04
Depth (in Ft)
0
2000
4000
6000
8000
10000
12000
14000
16000
P04
Legend:
CTD
ICAPS
SIMAS
33°18'N
APRIL
154°03'E

Fig. 11

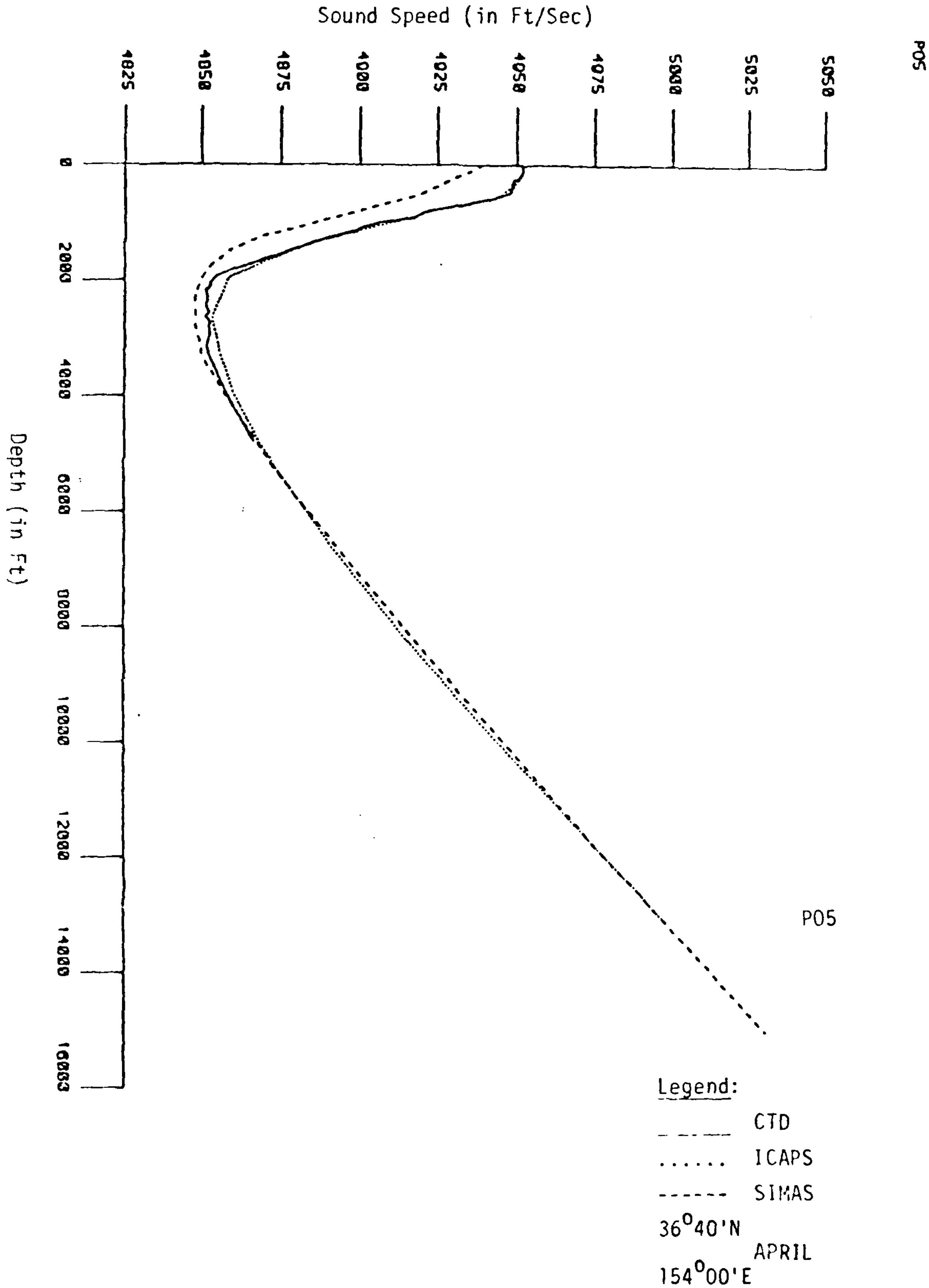

Sound Speed (in Ft/Sec)
4825
4850
4875
4900
4925
4950
4975
5000
5025
5050
P05
Depth (in Ft)
0
2000
4000
6000
8000
10000
12000
14000
16000
P05
Legend:
CTD
ICAPS
SIMAS
36°40'N
APRIL
154°00'E

Fig. 12

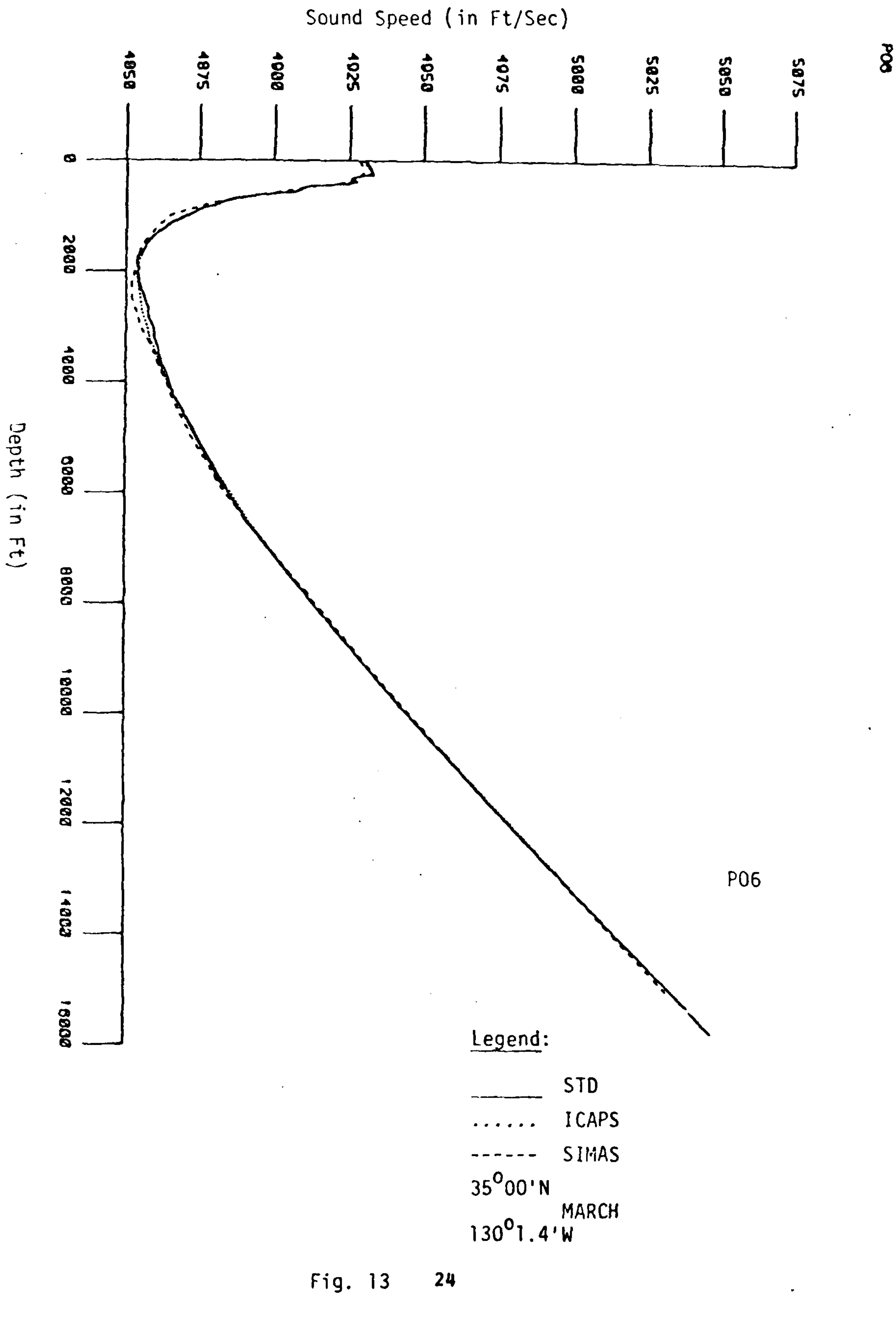
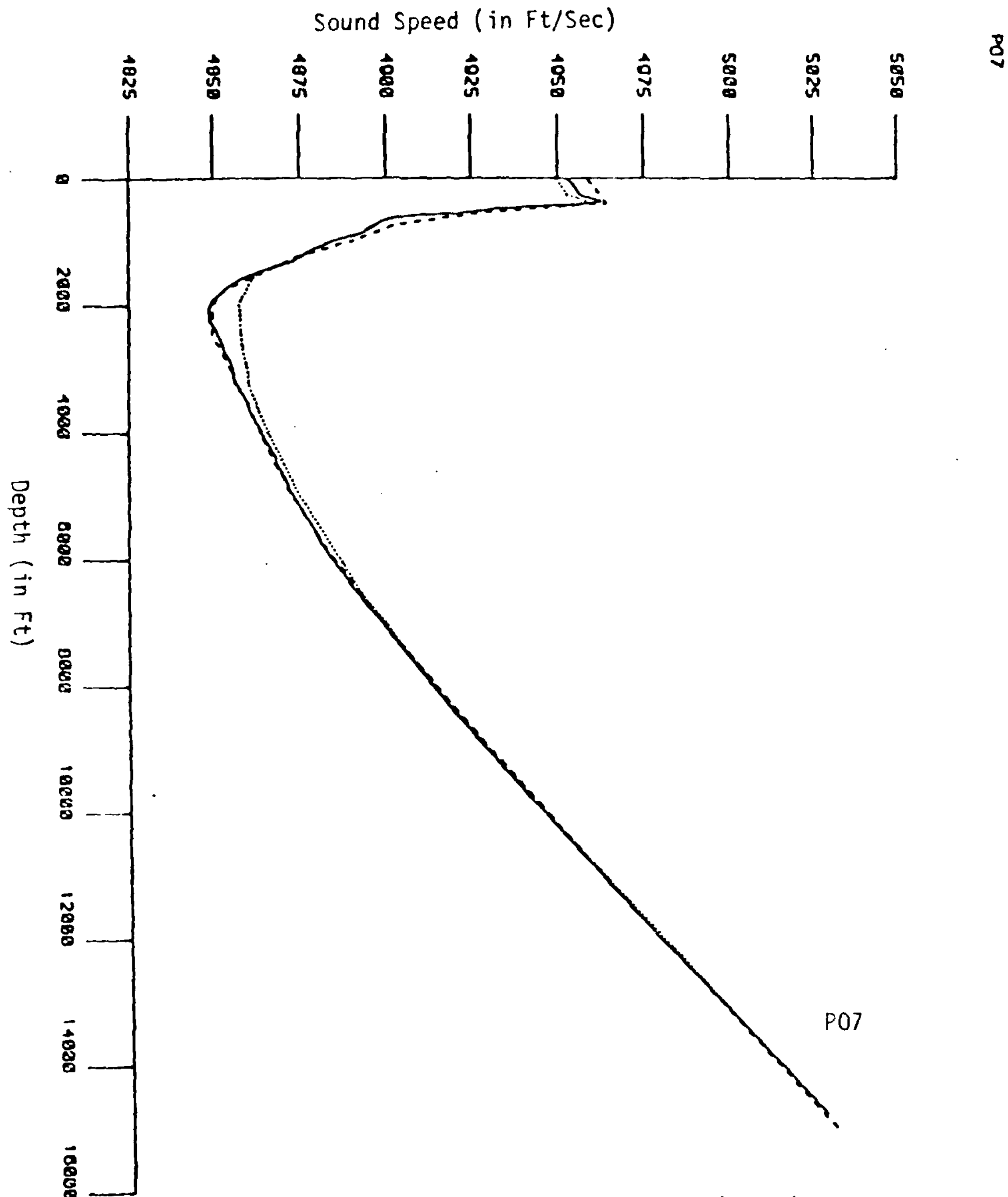

Sound Speed (in Ft/Sec)
Depth (in Ft)
P06
P06
Legend:
STD
ICAPS
SIMAS
35°00'N
MARCH
130°1.4'W

Fig. 13



Legend:

______ STD

.... ICAPS

------- SIMAS

35°00'N

137°59'W MARCH

Fig. 14

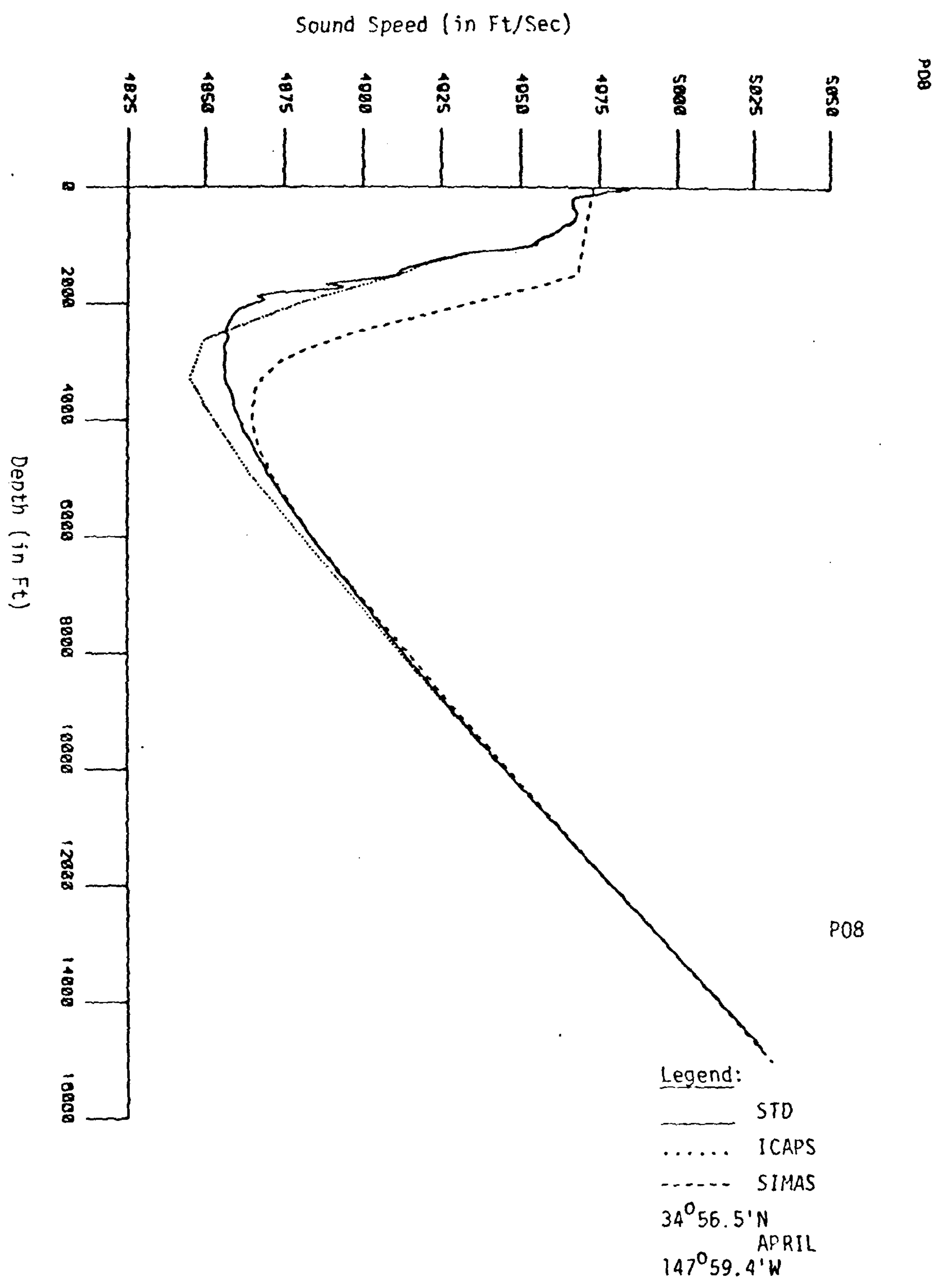

Sound Speed (in Ft/Sec)
4825
4850
4875
4900
4925
4950
4975
5000
5025
5050
P08
Depth (in Ft)
0
2000
4000
6000
8000
10000
12000
14000
16000
P08
Legend:
STD
ICAPS
SIMAS
34°56.5'N
APRIL
147°59.4'W

Fig. 15

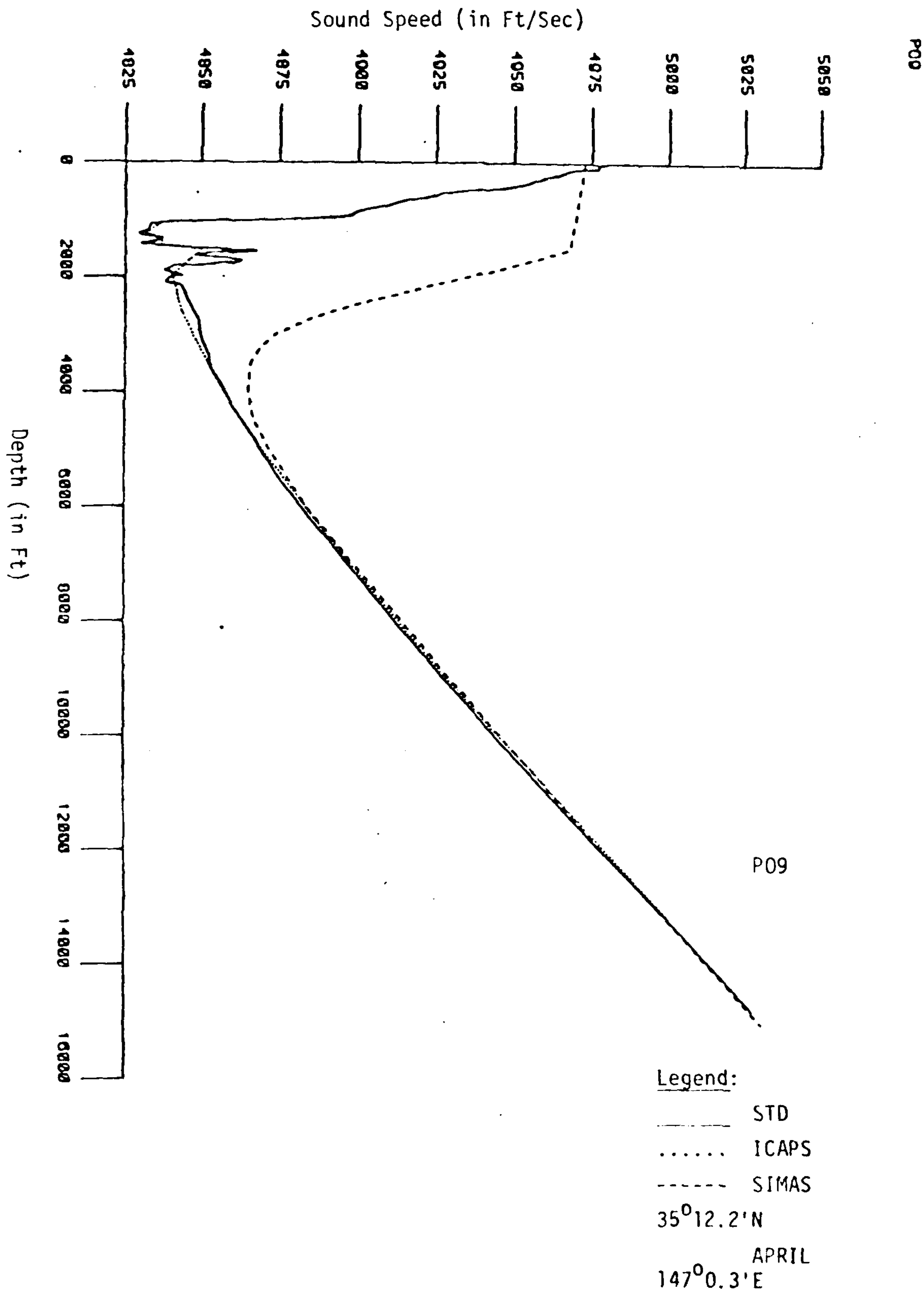

Sound Speed (in Ft/Sec)
Depth (in Ft)
0
2000
4000
6000
8000
10000
12000
14000
16000
P09
Legend:
STD
ICAPS
SIMAS
35°12.2'N
APRIL
147°0.3'E

Fig. 16

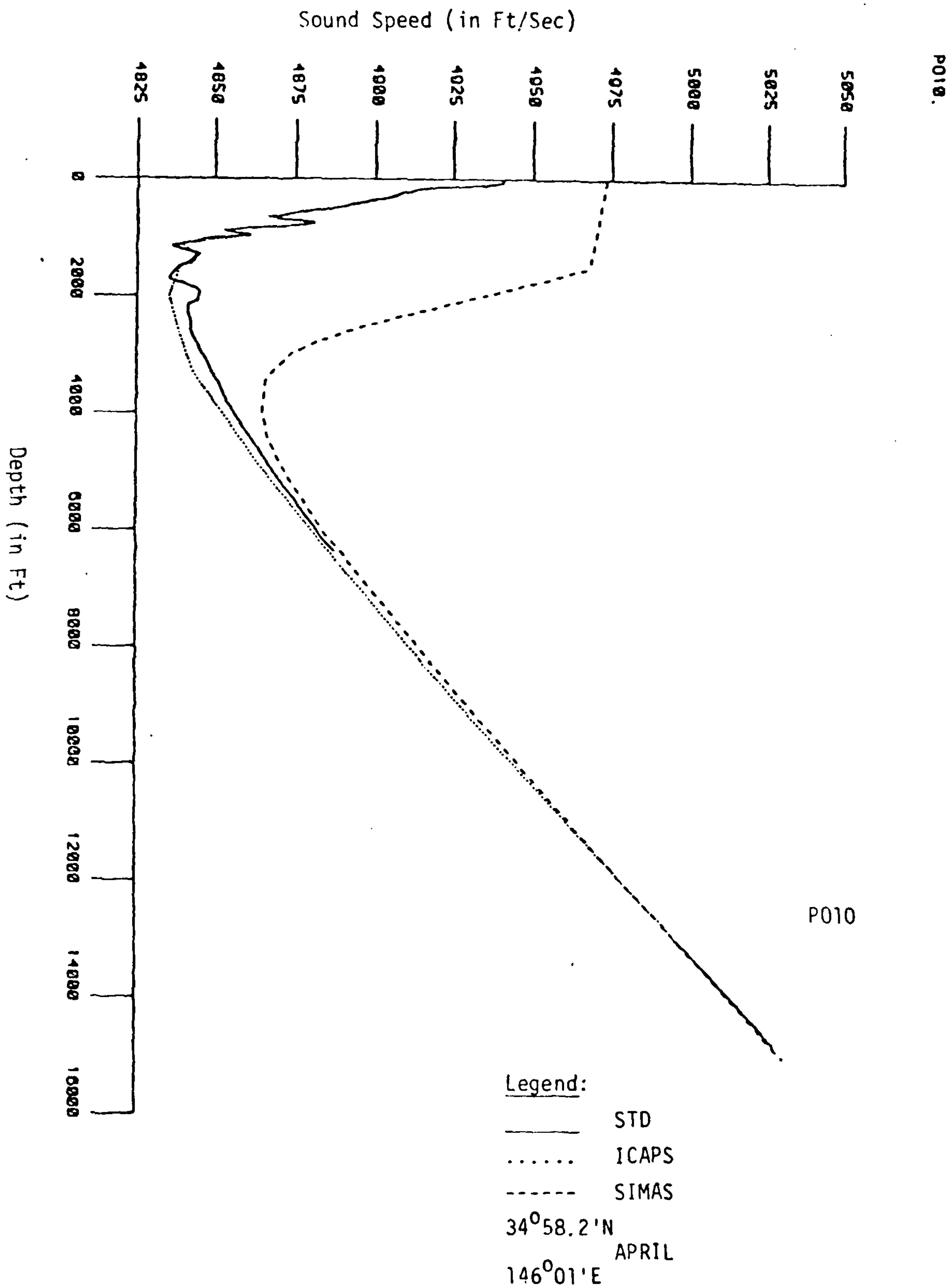

Sound Speed (in Ft/Sec)
4825
4850
4875
4900
4925
4950
4975
5000
5025
5050
P010.
Depth (in Ft)
0
2000
4000
6000
8000
10000
12000
14000
16000
P010
Legend:
STD
ICAPS
SIMAS
34°58.2'N
APRIL
146°01'E

Fig. 17

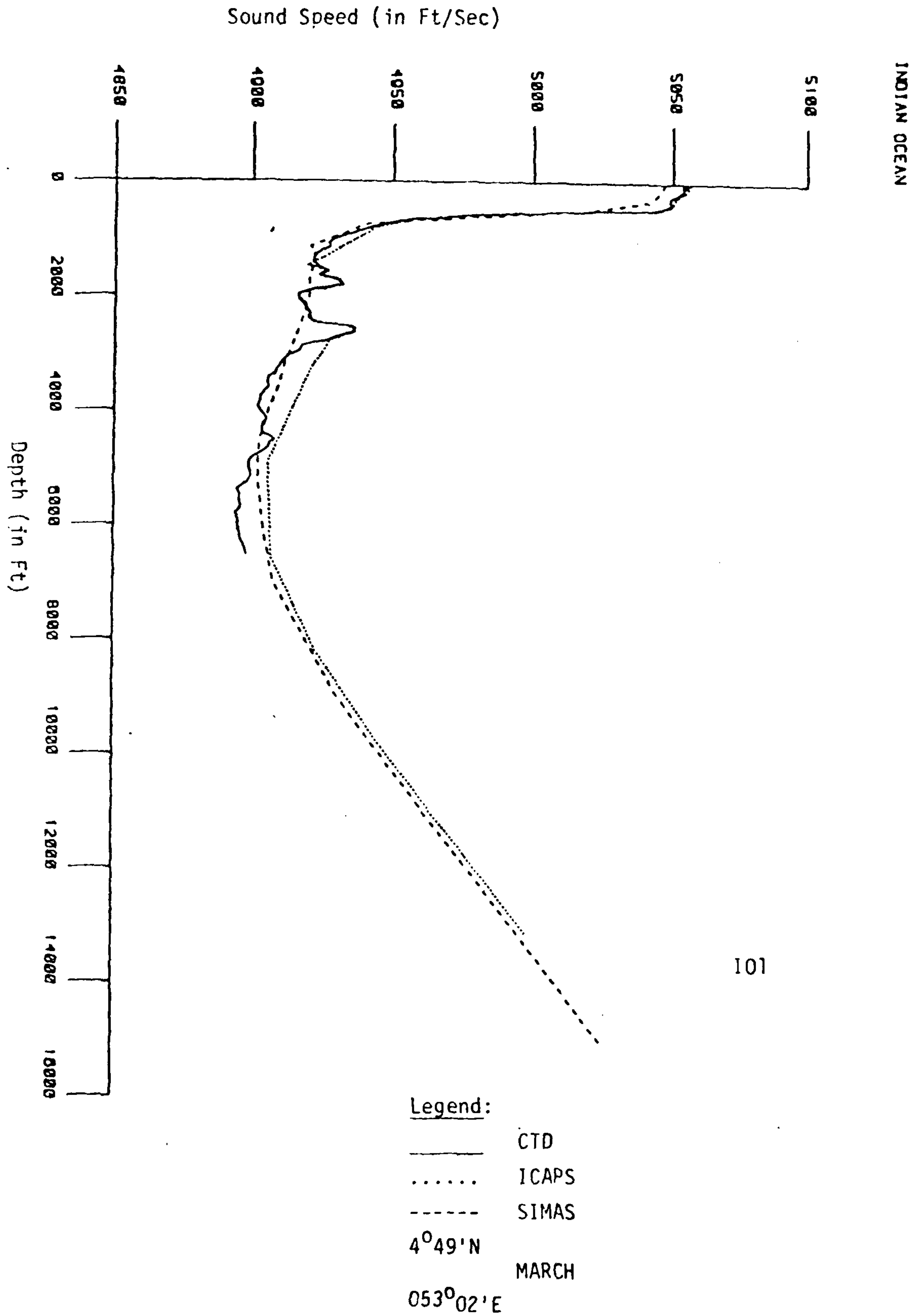

Sound Speed (in Ft/Sec)
INDIAN OCEAN
4850
4900
4950
5000
5050
5100
Depth (in Ft)
0
2000
4000
6000
8000
10000
12000
14000
16000
101
Legend:
CTD
ICAPS
SIMAS
4°49'N
MARCH
053°02'E

Fig. 18

TABLE (I) DESIGNATORS & LOCATIONS OF SELECTED SITES FOR SIMAS, ICAPS AND CTD/STD COMPARISONS

North Pacific Ocean	Latitude	Longitude	Month
P01	43°00'N	158°02'W	(September)
P02	35°59'N	158°00'W	(October)
P03	27°20'N	154°01'E	(April)
P04	33°18'N	154°03'E	(April)
P05	36°40'N	154°00'E	(April)
P06	35°00'N	130°1.4'W	(March)
P07	35°00'N	137°59'W	(March)
P08	34°56.5'N	147°59.4'W	(March)
P09	35°12.2'N	147°0.3'E	(April)
P10	34°58.2'N	146°01'E	(April)
Indian Ocean			
I01	4°49'N	053°02'E	(March)
North Atlantic Ocean			
A01	37°00'N	018°00'W	(February)
A02	36°00'N	019°00'W	(February)
A03	35°22.7'N	035°4.7'W	(June)
A04	35°12.4'N	054°59.0'W	(July)
A05	30°24.6'N	071°57.8'W	(September)
A06	30°25.6'N	071°57.0'W	(September)

TABLE (II)

Sources for the CTD and STD Test Cases

I. Scripps Institute for Oceanography

a) CTD
J. Reid and K. Kenyon P01, P02, P03, P04, P05

b) STD
J. Reid and K. Kenyon P06, P07, P08, P09, P10

II. Woods Hole Oceanographic Institute

a) CTD
M. McCartney A05, A06

III. Naval Ocean Research and Development Activity

a) CTD
H. Perkins and D. Fenner A01, A02, I01

IV. Naval Oceanographic Office

a) CTD
LCDR L. Danzler A03, A04

TABLE III. Numerical values of $\vec{SS}$ (in feet/sec) at the surface, and quantitative differences in $\vec{SS}$ (in feet/sec) at the surface.

Point Identifier	Point location	Values of $\vec{SS}$ (in ft/sec) at the surface			Differences in $\vec{SS}$ (in ft/sec) at the surface	
		SIMAS	ICAPS	Assumed Oceanography	SIMAS-Assumed Oceanography	ICAPS-Assumed Oceanography
A01	37°00'N 018°00'W	4965.95	4955.65	4955.65	10.00	not applicable
A02	36°00'N 019°00'W	4965.95	4953.68	4953.02	12.93	.65
A03	35°22.7'N 035°4.7'W	5007.00	5008.14	5008.47	-1.47	-0.33
A04	35°12.4'N 054°59'W	5034.70	5036.03	5037.01	-2.31	-0.98
A05	30°24.6'N 071°57.8'W	5059.50	5059.65	5060.30	-0.80	-0.65
A06	30°25.6'N 071°57'W	5056.90	5057.35	5057.68	-0.78	-0.33
P01	43°00'N 158°02'W	4951.84	4954.34	4953.35	-1.51	0.99
P02	35°59'N 158°00'W	5014.93	5005.19	5002.89	12.04	2.30
P03	27°20'N 154°01'E	4994.43	4999.61	4998.63	-4.20	0.98
P04	33°18'N 154°03'E	4974.94	4945.15	4944.49	30.45	0.66
P05	36°40'N 154°00'E	4938.95	4953.35	4952.37	-13.42	0.98
P06	35°00'N 150°1.4'W	4927.73	4929.40	4930.39	-2.66	-0.99
P07	35°00'N 137°59'W	4958.44	4949.41	4952.66	5.78	-3.25
P08	3[illegible]°56.5'N 147°59.4'W	4972.94	4983.54	4983.40	-10.46	0.14
P09	35°12.2'N 147°0.3'E	4972.94	4979.27	4979.60	-6.66	-0.33
P10	34°58.2'N 146°01'E	4972.94	4940.55	4940.10	32.84	0.45
I01	4°49'N 053°02'E	5047.40	5056.70	5055.05	-7.65	1.65

TABLE IV. Numerical values of $\vec{SS}$ (in feet/sec at the layer, and quantitative differences in $\vec{SS}$ (in feet/sec) at the layer.

[illegible]	Point Location	Values of $\vec{SS}$ (in ft/sec) at the layer			[illegible] $\vec{SS}$ [illegible] at the layer	
		SIMAS	ICAPS	Assumed [illegible]	[illegible]	[illegible]
401	37°00'N 018°[illegible]'W	4967.75	4959.91	4959.26	[illegible]	.65
402	36°00'N 019°00'W	4965.95	4954.99	4954.66	11.[illegible]	[illegible]
[illegible]3	35°22.7'N [illegible]5°4.7'W	5008.10	5009.13	[illegible].13	-1.[illegible]	[illegible]
[illegible]4	35°12.4'N [illegible]4°[illegible]'W	[illegible]	[illegible]	[illegible].01	-1.11	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible].10	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	43°[illegible]'N [illegible]'W	4952.14	4964.34	4964.01	-[illegible].87	[illegible]
[illegible]	[illegible]'N [illegible]'W	5015.[illegible]	[illegible]005.52	5003.88	11.44	[illegible]
[illegible]	27°[illegible]0'N 154°01'E	4[illegible]94.43	4999.61	4998.63	-4.70	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]15.48	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]°40'N [illegible]°[illegible]'E	49[illegible]9.25	4953.35	49[illegible]2.37	[illegible]	[illegible]
[illegible]	[illegible]1.4'W	[illegible]30.02	493[illegible].03	493[illegible].85	-2.[illegible]	[illegible]
[illegible]	[illegible]'N	[illegible]64.05	[illegible]2.93	4962.44	1.[illegible]	[illegible].91
[illegible]	[illegible]	[illegible]	4934.19	[illegible].76	[illegible]	[illegible]
[illegible]	35°17.[illegible]'N 147°0.3'E	4972.94	[illegible]76.97	[illegible]	[illegible]	[illegible]
[illegible]	3[illegible]°[illegible].2'N 136°01'E	4973.04	[illegible]940.55	[illegible]	[illegible]	[illegible]
[illegible]	4[illegible]°[illegible]'N [illegible]'E	[illegible]047.40	[illegible]	[illegible].71	-8.[illegible]	[illegible]

TABLE V. Numerical values of $\overrightarrow{SS}$ (in feet/sec) at 1000 feet, and quantitative differences in $\overrightarrow{SS}$ (in eet/sec) at 1000 feet.

Point Identifier	Point Location	Values of $\overrightarrow{SS}$ (in ft/sec) at 1000 feet: SIMAS	ICAPS	Assumed Oceanography	Differences in $\overrightarrow{SS}$ (in ft/sec) at 1000 feet: SIMAS-Assumed Oceanography	ICAPS-Assumed Oceanography
A01	37°00'N 014°[illegible]0'W	4945.94	4936.50	4936.62	9.32	-0.12
A02	36°[illegible]0'N 01[illegible]°[illegible]0'W	4945.94	4936.49	4935.75	10.19	0.74
A03	35°22.7'N 035°4.7'W	4960.0	4944.12	4943.80	16.20	0.32
A04	[illegible]°12.4'N 054°[illegible]'W	4992.0	4993.96	4994.61	-2.61	-0.65
A05	30°[illegible]4.6'N 071°[illegible]'W	4999.0	5000.40	5000.11	-1.11	0.29
A06	30°[illegible].6'N 07[illegible]°57'W	4999.0	5001.46	5001.10	-2.10	0.36
F01	[illegible]°[illegible]'N 15[illegible]°02'W	4856.93	4862.6	4862.38	-5.45	0.22
F02	35°59'N 15[illegible]°[illegible]'W	4917.95	4901.28	4899.10	18.85	2.18
F03	27°[illegible]0'N 153°01'E	4955.94	4959.81	4959.24	-3.30	0.57
F04	33°[illegible]'N 154°03'E	4971.20	4849.64 4889.64	4886.54	84.66	3.10
F05	36°[illegible]0'N 1[illegible]4°[illegible]'E	4886.95	4909.85	4906.91	-19.96	2.94
F06	[illegible]°[illegible]'N 1[illegible]°1.4'W	4864.93	4870.33	4871.22	-6.29	-0.89
F07	[illegible]°[illegible]'N 13[illegible]°59'N	4889.93	4884.20	4884.96	4.97	-0.76
F08	34°[illegible].5'N 14[illegible]°[illegible]9.4'W	4969.62	4954.44	4953.18	16.44	1.26
F09	35°12.2'N 147°0.3'E	4969.61	4873.60	4880.59	89.02	-6.99
P10	34°58.2'N 146°01'E	4969.73	4856.26	4853.29	116.44	2.97
I01	4°49'N 053°02'E	4928.0	4937.12	4929.55	-1.55	7.57

TABLE VI. Numerical values of $\overleftrightarrow{SS}$ (in feet/sec) at the channel axis, quantitative differences in $\overleftrightarrow{SS}$ (in feet/sec) at the channel axis.

[illegible]	Point location	Values of $\overleftrightarrow{SS}$ (in ft/sec) at the channel axis			[illegible] at the channel axis	
		SIMAS	ICAPS	Assumed Oceanography	[illegible]	[illegible]
[illegible]	[illegible]7°00'N 018°00'W	4926.94	4924.15	4917.92	[illegible]	6.[illegible]
[illegible]	[illegible]°00'N [illegible]°00'W	4926.94	4924.15	4916.28	[illegible]	[illegible]
[illegible]	[illegible]°[illegible]2.7'N [illegible]°4.7'W	[illegible].00	4902.83	not applicable	not applicable	not applicable
[illegible]	[illegible]°12.4'N [illegible]'W	[illegible].00	4888.39	not applicable	not applicable	not applicable
[illegible]	[illegible]°24.6'N 071°57.8'W	4891.00	4899.55	[illegible].94	[illegible]	[illegible]
[illegible]	[illegible]°25.6'N 071°57'W	4891.00	4899.22	4896.92	-5.92	[illegible]
[illegible]	[illegible]°[illegible]0'N [illegible]°02'W	not applicable			not applicable	not applicable
	[illegible]°[illegible]9'N [illegible]°00'W	[illegible]3.95	4861.49	4849.68	4.27	[illegible]
[illegible]	[illegible]°20'N [illegible]'E	4861.95	4859.52	4856.89	[illegible]	[illegible]
[illegible]	[illegible]°18'N 154°03'E	4864.93	4844.43	4844.76	20.17	[illegible]
[illegible]	[illegible] 15[illegible]°00'E	[illegible]47.94	4863.29	4861.32	[illegible]	1.[illegible]7
[illegible]	[illegible]	4861.94	4853.61	[illegible]4.34	-[illegible].40	[illegible].73
[illegible]	[illegible]	[illegible]49.94	4857.[illegible]	[illegible]49.82	1.12	9.06
[illegible]	[illegible]°[illegible]6.5'N 147°59.[illegible]'W	4864.93	4846.09	4855.98	8.95	-10.89
[illegible]9	35°12.2'N [illegible]°0.3'E	[illegible]64.93	4840.82	4838.43	26.50	2.39
P10	34°[illegible]8.2'N 146°01'E	[illegible]64.93	4835.24	4835.31	29.62	[illegible].07
[illegible]11	4°4[illegible]'N [illegible]53°02'E	4[illegible]02.00	4905.78	4894.30	7.70	11.48

TABLE VII. Numerical values of layer depth (in feet), quantitative differences in the depths of the layer (in feet).

Point Identifier	Point Location	Values of the layer depth (in ft)			Differences in layer depth (in ft)	
		SIMAS	ICAPS	Assumed Oceanography	SIMAS-Assumed Oceanography	ICAPS-Assumed Oceanography
A01	37°00'N 018°00'W	108.30	337.92	367.45	-259.15	-29.53
A02	36°00'N 019°00'W	0	154.20	387.13	-387.13	-232.93
A03	35°22.7'N 035°4.7'W	65.90	65.62	65.62	.28	0
A04	35°12.4'N 054°59'W	24.6	36.09	0	24.60	36.09
A05	30°24.6'N 071°57.8'W	36.10	65.62	32.81	3.29	32.81
A06	30°25.6'N 071°57'W	88.60	88.58	88.58	.02	0
P01	43°00'N 158°02'W	78.71	0	88.58	-9.87	-88.58
P02	35°59'N 158°00'W	78.71	127.95	98.42	-19.71	29.53
P03	27°20'N 154°01'E	0.0	0.0	0.0	0	0
P04	33°18'N 154°03'E	59.09	78.74	49.21	9.88	29.53
P05	35°40'N 154°00'E	19.68	0.0	98.42	-78.74	-98.42
P06	35°00'N 130°1.4'W	205.71	206.69	225.57	-19.86	-18.88
P07	35°[illegible]0'N 137°[illegible]9'W	401.90	367.45	368.11	33.79	-.66
[illegible]	[illegible]	2.0	36.09	37.73	-35.73	-1.64
P09	35°12.2'N 147°0.3'E	0	36.09	13.12	-13.12	22.97
P10	34°58.2'N 146°01'E	70.90	68.90	39.37	31.53	29.53
I01	4°49'N 053°02'E	0	0	9.84	-9.84	-9.84

TABLE VIII. Numerical values of the channels axis depth (in feet), quantitative differences in the depths of the channel axis (in feet.)

Point Identifier	Point Location	Values of the channel axis depth (in ft)			Differences in the channel axis (in ft) depth	
		SIMAS	ICAPS	Assumed Oceanography	SIMAS-Assumed Oceanography	ICAPS-Assumed Oceanography
A01	37°00'N 016°00'W	6999.91	6561.60	5721.71	438.31	839.89
A02	36°00'N 019°00'W	6999.91	6561.60	5600.32	1399.58	961.28
A03	35°22.7'N 075°4.7'W	5000.00	4429.03	not applicable	not applicable	not applicable
A04	35°12.4'N [illegible]	4000.00	3936.96	not applicable	not applicable	not applicable
[illegible]	30°24.6'N 071°57.8'W	4500.00	3936.96	4268.32	231.68	-331.36
A06	30°25.6'N 071°57'W	4500.00	3936.96	4248.64	251.36	-311.68
[illegible]	43°50'N 158°02'W	not	applicable		not applicable	not applicable
[illegible]	[illegible] 158°00'W	2749.97	2624.64	2618.08	131.89	6.56
[illegible]03	27°20'N 154°01'E	3499.96	3280.80	3257.83	242.13	22.97
[illegible]	35°13'N 154°03'E	3999.95	2624.64	2145.64	1854.31	479.00
[illegible]	[illegible]°40'N 154°00'E	2499.97	2624.64	2627.92	-127.95	-3.28
[illegible]	[illegible]	2374.97	1968.48	2059.36	315.61	-90.88
7	36°00'N 137°59'N	2249.97	1968.48	2060.01	189.96	-91.53
[illegible]	[illegible]	3999.95	3280.80	3058.03	941.92	941.92
[illegible]09	35°12.2'N 147°0.3'E	3999.95	1968.48	2089.87	1910.08	-121.39
[illegible]10	34°58.2'N 146°01'E	3999.95	1968.48	1712.91	2287.04	255.57
[illegible]	4°49'N [illegible]°02'E	5000.00	4921.20	5800.78	-800.78	-879.58

TABLE (IX)

Qualitative Differences in SS
at the surface

LEGEND: slight < 1 f/s
1 f/s < SS < 7 f/s
7 f/s < SS* < 20 f/s
20 f/s < SS** < 40 f/s

SITE (ID)	Differences in SS at the surface	
	SIMAS	ICAPS
A01	SS*	none
A02	SS*	slight
A03	SS	slight
A04	SS	slight
A05	slight	slight
A06	slight	slight
P01	SS	slight
P02	SS*	SS
P03	SS	slight
P04	SS**	slight
P05	SS*	slight
P06	SS	slight
P07	SS	SS
P08	SS*	slight
P09	SS	slight
P10	SS**	slight
I01	SS*	SS

TABLE (X)

Qualitative Differences in SS at the layer

LEGEND: slight < 1 f/s
1 f/s < SSL < 7 f/s
7 f/s < SSL* < 20 f/s
20 f/s < SSL** < 40 f/s

SITE (ID)	Differences in SS at the layer	
	SIMAS	ICAPS
A01	SSL*	slight
A02	SSL*	slight
A03	SSL	none
A04	SSL	slight
A05	slight	slight
A06	slight	slight
P01	SSL	slight
P02	SSL*	SSL
P03	SSL	slight
P04	SSL**	none
P05	SSL*	slight
P06	SSL	slight
P07	SSL	SSL
P08	SSL*	slight
P09	SSL	SSL
P10	SSL**	slight
I01	SSL*	slight

TABLE (XI)

Qualitative Differences in SS
at 1000 feet

LEGEND: slight < 1 f/s
1 f/s < SS1000 < 6 f/s
6 f/s < SS1000* < 12 f/s
12 f/s < SS1000** < 20 f/s
20 f/s < SS1000*** < 75 f/s
75 f/s < SS1000**** < 100 f/s
100 f/s < SS1000*****

SITE (ID)	Differences in SS at the 1000' feet: SIMAS	ICAPS
A01	SS1000*	slight
A02	SS1000*	slight
A03	SS1000**	slight
A04	SS1000	slight
A05	SS1000	slight
A06	SS1000	slight
P01	SS1000	slight
P02	SS1000**	SS1000
P03	SS1000	slight
P04	SS1000****	SS1000
P05	SS1000**	SS1000
P06	SS1000*	slight
P07	SS1000	slight
P08	SS1000**	SS1000
P09	SS1000****	SS1000*
P10	SS1000*****	SS1000*
I01	SS1000	SS1000*

TABLE (XII)

Qualitative Differences in SS at the channel axis

LEGEND:
-- = no comparison made
slight < 1 f/s
1 f/s < SSCA < 3 f/s
3 f/s < SSCA* < 7 f/s
7 f/s < SSCA** < 12 f/s
12 f/s < SSCA*** < 20 f/s
20 f/s < SSCA****

SITE (ID)	Differences in SS at the channel axis	
	SIMAS	ICAPS
A01	SSCA**	SSCA**
A02	SSCA**	SSCA**
A03	--	--
A04	--	--
A05	SSCA*	SSCA*
A06	SSCA*	SSCA*
P01	--	--
P02	SSCA*	SSCA**
P03	SSCA*	SSCA
P04	SSCA****	slight
P05	SSCA*	SSCA
P06	SSCA	slight
P07	SSCA	SSCA**
P08	SSCA**	SSCA**
P09	SSCA****	SSCA
P10	SSCA****	slight
I01	SSCA**	SSCA**

TABLE (XIII)

Qualitative Differences in SS
at the layer depth

LEGEND: slight < 2 ft
2 ft < DLD < 30 ft
30 ft < DLD* < 90 ft
90 ft < DLD** < 150 ft
150 ft < DLD*** < 250 ft
250 ft < DLD****

SITE (ID)	Differences in layer depth (in feet)	
	SIMAS	ICAPS
A01	DLD****	DLD
A02	DLD****	DLD***
A03	slight	none
A04	DLD	DLD*
A05	DLD	DLD*
A06	slight	none
P01	DLD	DLD*
P02	DLD	DLD
P03	none	none
P04	DLD	DLD
P05	DLD*	DLD**
P06	DLD	DLD
P07	DLD*	DLD
P08	DLD*	DLD
P09	DLD	DLD
P10	DLD*	DLD
I01	DLD	DLD

TABLE (XIV)

Qualitative Differences in the depth of the channel axis

LEGEND:
---- = no comparisons made
0 ft < DSCA < 300 ft
300 ft < DSCA* < 600 ft
600 ft < DSCA** < 1200 ft
1200 ft < DSCA*** < 2000 ft
2000 ft < DSCA****

SITE (ID)	Differences in the depth of sound channel axis (in feet) SIMAS	ICAPS
A01	DSCA*	DSCA**
A02	DSCA***	DSCA**
A03	--	--
A04	--	--
A05	DSCA	DSCA*
A06	DSCA	DSCA**
P01	--	--
P02	DSCA	DSCA
P03	DSCA	DSCA
P04	DSCA***	DSCA*
P05	DSCA	DSCA
P06	DSCA*	DSCA
P07	DSCA	DSCA
P08	DSCA**	DSCA**
P09	DSCA***	DSCA
P10	DSCA****	DSCA
I01	DSCA**	DSCA**

TABLE (XV). Numerical values of sound speeds (in feet/sec) for "assumed oceanography" profiles

ATLANTIC OCEAN

A01

0.00	4955.65	209.97	4957.29	367.45	4959.26	374.01	4958.60
380.57	4957.29	387.13	4955.98	393.70	4954.01	410.10	4952.70
413.38	4951.05	416.66	4949.41	423.22	4948.10	429.78	4946.79
436.35	4945.15	452.75	4943.51	479.00	4942.20	498.68	4942.85
544.61	4941.21	580.70	4939.57	646.32	4940.23	685.69	4938.59
738.18	4937.93	800.52	4941.54	810.36	4938.59	830.04	4939.90
853.01	4938.26	869.41	4935.30	902.22	4935.30	954.71	4934.00
1000.64	4936.62	1026.89	4934.98	1059.70	4932.03	1092.51	4934.32
1187.65	4933.34	1263.11	4934.65	1407.46	4933.34	1446.83	4931.70
1614.15	4933.01	1886.46	4934.65	2116.12	4937.61	2185.01	4935.96
2263.75	4938.91	2309.68	4938.26	2316.24	4936.62	2378.58	4935.96
2536.06	4938.26	2641.32	4935.30	2683.69	4938.26	2726.34	4937.61
2729.63	4936.95	2772.28	4938.59	2782.12	4940.55	2818.21	4942.85
2847.73	4941.21	2877.26	4942.20	2887.10	4945.48	2916.63	4945.48
2939.60	4943.84	2949.44	4941.21	2995.37	4943.18	3067.55	4944.82
3070.83	4945.15	3074.11	4946.79	3077.39	4948.43	3129.88	4950.40
3159.41	4948.43	3205.34	4951.38	3366.10	4954.66	3625.28	4955.98
3999.29	4952.70	4081.31	4949.41	4205.98	4946.13	4432.36	4942.85
4488.13	4939.90	4563.59	4936.62	4694.82	4933.34	4819.50	4930.06
5006.50	4926.78	5173.82	4923.50	5337.86	4920.54	5721.71	4917.92
6184.31	4919.23	6440.21	4919.56	6561.60	4921.20	8202.00	4936.62
9842.40	4958.93	11482.80	4984.19	13123.20	5010.77	14763.60	5038.00
16404.00	5066.87	16640.22	5071.13				

ATLANTIC OCEAN

A 02

0.00	4953.02	387.13	4954.66	413.38	4953.68	416.66	4953.02
419.94	4952.37	429.78	4952.04	446.19	4950.40	456.03	4948.76
465.87	4947.45	475.72	4945.80	495.40	4944.16	528.21	4942.52
570.86	4940.88	652.88	4940.23	728.34	4941.87	764.43	4943.51
816.92	4941.87	836.60	4940.23	859.57	4938.59	902.22	4936.95
1036.73	4935.30	1151.56	4933.67	1561.66	4933.01	1761.79	4934.65
1863.49	4936.29	1978.32	4937.93	2050.50	4939.57	2076.75	4941.21
2142.36	4942.85	2194.86	4944.49	2250.63	4946.13	2316.24	4947.77
2388.42	4949.41	2460.60	4951.05	2532.78	4952.70	2647.61	4954.34
2726.34	4954.99	2811.65	4953.68	2847.73	4955.32	3087.23	4956.96
3146.29	4954.66	3477.65	4956.30	3602.32	4957.95	3871.34	4957.95
4051.79	4956.30	4120.68	4954.66	4140.37	4953.02	4228.95	4949.74
4304.41	4946.46	4389.71	4943.18	4478.29	4940.23	4550.47	4936.95
4635.77	4933.67	4671.86	4930.39	4763.72	4927.43	4917.92	4925.79
4924.48	4924.81	4993.38	4923.17	5068.84	4921.53	5180.38	4919.89
5452.69	4918.25	5600.32	4916.28	5688.91	4917.92	5967.77	4919.56
6151.50	4921.20	6299.14	4922.84	6492.70	4924.48	6561.60	4925.46
7611.46	4937.61	8202.00	4940.55	8320.11	4940.88	9842.40	4959.26
11482.80	4984.52	13123.20	5010.77	14763.60	5038.00	16404.00	5066.87
16879.71	5075.40						

A 03

0.00	5008.47	42.65	5008.47	65.62	5009.13	88.58	5006.17
108.27	4986.82	131.23	4977.30	177.16	4970.74	200.13	4965.49
249.34	4960.24	272.31	4957.95	341.20	4957.29	508.52	4953.68
705.37	4951.71	744.74	4952.04	912.06	4948.10	997.36	4943.84
1174.53	4940.88	1213.90	4939.25	1430.43	4935.64	1601.03	4934.32
1728.98	4931.37	1856.93	4928.09	1899.58	4928.42	2109.55	4925.14
2283.44	4922.18	2326.09	4919.56	2447.48	4917.26	2828.05	4917.26
2956.00	4916.28	3038.02	4915.95				

A 04

0.00	5037.01	36.09	5037.01	52.49	5031.43	72.18	5024.87
95.14	5012.08	121.39	5004.86	147.64	4998.95	177.16	4995.02
246.06	4989.77	390.42	4988.13	790.67	4991.41	1026.89	4995.02
1259.83	4997.64	1312.32	4995.34	1414.02	4990.43	1512.45	4986.49
1610.87	4982.88	1706.02	4978.61	1801.16	4974.68	1899.58	4969.75
1994.73	4966.47	2093.15	4960.90	2139.08	4957.62	2237.51	4952.37
2283.44	4948.43	2381.86	4943.18	2431.07	4939.90	2526.22	4934.65
2621.36	4929.07	2670.57	4924.48	2719.78	4921.53	2765.71	4917.92

A 05

0.00	5060.30	13.12	5060.30	32.81	5060.63	82.02	5059.32
108.27	5057.35	121.39	5054.07	124.67	5052.10	127.95	5049.81
131.23	5046.20	134.51	5043.25	141.07	5040.29	147.64	5038.00
154.20	5035.04	157.48	5033.40	160.76	5031.11	173.88	5027.82
183.72	5025.53	196.85	5022.91	206.69	5019.95	229.66	5017.33
242.78	5014.05	265.74	5011.42	282.15	5009.13	305.11	5005.84
383.85	5002.56	567.58	4999.28	639.76	4998.63	744.74	4999.61
793.95	4999.28	938.31	5000.27	967.84	4999.94	1515.73	5002.89
1604.31	5002.89	1745.39	4999.61	1843.81	4996.33	1909.43	4993.05
1975.04	4989.77	2043.94	4986.82	2086.59	4983.54	2185.01	4980.25
2244.07	4976.97	2306.40	4973.69	2349.05	4970.41	2394.98	4967.13
2460.60	4963.85	2509.81	4960.57	2565.59	4957.29	2608.24	4954.01
2687.29	4950.73	2706.66	4947.45	2755.87	4944.16	2798.52	4941.21
2844.45	4937.61	2873.98	4934.65	2919.91	4931.70	2942.88	4928.42
3018.34	4925.14	3064.27	4921.86	3123.32	4919.56	3185.66	4915.95
3228.31	4912.67	3307.05	4909.72	3392.35	4906.44	3503.89	4903.16
3654.81	4899.88	3835.26	4896.59	3959.93	4897.58	4084.60	4896.59
4130.53	4897.25	4150.21	4896.27	4183.02	4897.58	4268.32	4895.94
4868.71	4899.22	5249.28	4902.50				

A 06

0.00	5057.68	13.12	5057.68	82.02	5059.32	88.58	5059.98
91.86	5059.32	95.14	5058.34	98.42	5055.71	101.70	5053.41
104.99	5050.46	111.55	5047.84	124.67	5044.56	131.23	5041.28
144.36	5038.00	160.76	5034.71	173.88	5031.76	180.44	5029.46
190.29	5026.51	200.13	5024.21	206.69	5021.27	219.81	5017.98
239.50	5015.03	262.46	5012.08	291.99	5008.80	344.48	5005.52
462.59	5002.56	521.65	4999.94	1200.77	5001.58	1686.33	5003.22
1811.00	4999.94	1906.14	4996.66	1961.92	4993.38	2020.97	4990.10
2080.03	4986.82	2135.80	4983.86	2198.14	4980.58	2263.75	4977.63
2335.93	4974.35	2381.86	4971.07	2427.79	4968.11	2487.16	4964.83
2513.09	4961.88	2552.46	4958.93	2611.52	4955.65	2654.17	4952.37
2686.98	4948.76	2723.08	4945.80	2769.00	4942.52	2824.77	4938.91
2854.30	4935.96	2900.23	4932.68	2959.28	4929.40	3015.06	4926.12
3074.11	4922.84	3123.32	4919.56	3208.62	4916.28	3277.52	4913.32
3375.94	4910.04	3408.75	4906.77	3480.93	4903.81	3566.23	4900.53
3723.71	4897.58	3795.89	4898.56	4002.58	4896.92	4028.82	4897.58
4248.64	4896.92	4530.79	4898.23	4894.95	4901.52	5006.50	4900.86
5246.00	4902.50						

PACIFIC OCEAN

P01

0.00	4953.35	88.58	4954.01	98.42	4953.02	108.27	4949.74
118.11	4941.87	127.95	4930.71	137.79	4919.23	147.64	4910.70
157.48	4905.45	167.32	4902.83	196.85	4899.55	236.22	4899.88
275.59	4897.25	285.43	4895.61	305.11	4892.00	324.80	4889.38
344.48	4886.09	354.33	4884.13	364.17	4881.17	374.01	4878.22
383.85	4875.27	403.54	4871.00	413.38	4870.02	462.59	4873.30
482.28	4875.60	501.96	4879.21	541.33	4880.85	620.07	4877.89
708.65	4874.61	757.86	4871.99	797.23	4869.04	875.97	4866.08
984.24	4863.13	1053.14	4859.85	1122.03	4856.24	1171.25	4853.61
1279.51	4850.34	1368.09	4847.38	1496.04	4844.10	1653.52	4842.46
1712.58	4842.46	1811.00	4843.12	1998.01	4842.13	2637.76	4845.41
3110.20	4846.37	3444.84	4851.64	3809.01	4854.93	4084.60	4857.88
4379.87	4861.16	4635.77	4864.11	4871.99	4867.07	4921.20	4867.72

P02

0.00	5002.89	98.42	5003.88	147.64	5000.92	157.48	4996.66
167.32	4989.44	177.16	4979.60	187.01	4969.10	196.85	4959.91
206.69	4953.35	216.53	4948.76	226.38	4945.48	236.22	4942.85
246.06	4940.55	255.90	4937.93	265.74	4935.30	275.59	4932.68
285.43	4929.73	295.27	4926.78	305.11	4923.82	314.96	4920.87
324.80	4918.25	334.64	4915.62	344.48	4913.32	354.33	4911.36
364.17	4910.04	374.01	4909.39	393.70	4907.75	413.38	4907.09
511.80	4906.11	561.02	4909.39	610.23	4912.67	639.76	4913.32
738.18	4910.04	816.92	4906.77	905.50	4903.81	994.08	4900.53
1092.51	4897.25	1171.25	4894.30	1249.98	4891.34	1309.04	4888.06
1377.94	4884.78	1427.15	4881.83	1476.36	4878.88	1545.26	4875.93
1594.47	4872.97	1624.00	4870.35	1663.37	4867.07	1732.26	4864.11
1830.69	4861.16	1899.58	4858.21	2017.69	4854.93	2224.38	4851.64
2490.13	4850.00	2618.08	4849.68	3257.83	4852.30	3710.58	4855.58
4045.23	4858.86	4291.29	4862.14	4645.61	4865.43	4921.20	4868.71

PACIFIC OCEAN

P03

0.00	4998.63	49.21	4995.34	98.42	4992.07	137.79	4985.50
157.48	4983.21	177.16	4980.25	196.85	4977.30	236.22	4974.35
324.80	4971.07	511.80	4968.77	757.86	4965.49	866.13	4962.54
984.24	4959.91	1053.14	4956.96	1112.19	4954.01	1181.09	4951.05
1259.83	4948.43	1299.20	4945.80	1338.57	4942.52	1387.78	4939.25
1427.15	4936.29	1476.36	4933.67	1515.73	4931.04	1555.10	4928.09
1584.63	4924.81	1604.31	4921.86	1633.84	4918.57	1692.89	4915.62
1722.42	4912.67	1751.95	4909.72	1781.47	4906.77	1820.84	4903.48
1860.21	4900.86	1899.58	4898.23	1929.11	4895.61	1958.64	4892.33
1998.01	4889.70	2017.69	4887.08	2037.38	4883.80	2066.90	4880.85
2116.12	4877.89	2175.17	4874.94	2263.75	4872.32	2312.96	4869.36
2431.07	4866.08	2490.13	4863.13	2568.87	4860.18	2657.45	4859.19
2716.50	4858.86	3228.31	4856.89	3287.36	4856.89	3769.64	4858.86
4143.65	4862.14	4625.93	4865.43	4921.20	4869.04		

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P04

0.00	4944.49	49.21	4945.48	108.27	4943.18	157.48	4942.52
246.06	4939.90	275.59	4937.61	305.11	4934.32	364.17	4931.70
413.38	4928.09	462.59	4925.14	541.33	4922.18	600.39	4918.90
620.07	4916.61	649.60	4913.65	708.65	4910.70	738.18	4908.08
757.86	4906.11	777.55	4903.48	807.08	4900.86	875.97	4897.25
905.50	4894.63	954.71	4891.34	994.08	4888.06	1053.14	4885.11
1102.35	4882.16	1131.88	4879.53	1161.40	4876.91	1200.77	4873.63
1230.30	4870.35	1249.98	4867.07	1289.35	4864.11	1348.41	4860.83
1377.94	358.21	1476.36	4854.93	1624.00	4852.30	1653.52	4849.68
1771.63	4847.05	1889.74	4847.05	2047.22	4844.76	2096.43	4845.09
2145.64	4844.76	2273.59	4847.38	2342.49	4847.05	2450.76	4846.07
2539.34	4846.40	2618.08	4845.74	2677.13	4845.74	3120.04	4849.02
3553.11	4852.30	3996.01	4855.58	4310.97	4858.86	4576.71	4862.14
4852.30	4865.43	4921.20	4866.41				

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P05

0.00	4952.37	49.21	4951.71	68.90	4952.04	98.42	4952.37
226.38	4951.05	265.74	4949.09	314.96	4948.76	344.48	4948.43
374.01	4948.76	393.70	4949.09	413.38	4948.76	423.22	4948.43
482.28	4948.10	492.12	4947.77	501.96	4947.45	561.02	4944.16
590.54	4941.87	610.23	4939.57	639.76	4935.96	679.13	4933.01
718.50	4930.06	748.02	4926.78	767.71	4924.15	807.08	4920.54
895.66	4917.92	915.34	4915.62	944.87	4912.34	974.40	4909.06
1003.92	4906.11	1043.29	4903.81	1082.66	4900.86	1151.56	4897.91
1190.93	4895.28	1230.30	4892.00	1279.51	4889.38	1338.57	4886.09
1397.62	4882.81	1456.68	4879.86	1515.73	4876.58	1574.78	4873.30
1633.84	4870.35	1702.74	4867.07	1751.95	4864.11	1801.16	4861.16
1860.21	4858.21	1919.27	4855.25	2066.90	4852.63	2106.27	4852.96
2125.96	4852.63	2165.33	4851.32	2362.18	4851.97	2431.07	4851.32
2568.87	4852.30	2627.92	4851.32	2696.82	4852.30	2755.87	4852.63
2814.93	4852.30	2972.40	4852.63	3169.25	4851.64	3267.68	4852.30
3681.06	4855.58	4035.38	4858.86	4350.34	4862.14	4675.14	4865.43
4803.09	4867.07						

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P06

0.00	4930.39	90.22	4931.30	171.59	4932.22	255.57	4932.85
271.65	4931.77	288.05	4928.98	303.47	4927.37	317.91	4926.19
401.90	4926.88	434.05	4924.84	452.42	4916.48	469.15	4910.60
483.26	4909.72	534.11	4908.70	549.53	4908.01	566.59	4906.70
583.98	4903.98	599.73	4900.76	615.48	4897.71	631.55	4892.66
648.61	4890.52	665.67	4889.24	681.75	4887.54	697.83	4885.87
731.62	4884.91	761.47	4881.83	824.47	4880.03	843.49	4877.99
877.29	4875.50	942.57	4873.07	1007.53	4870.64	1059.70	4868.31
1124.33	4865.69	1221.11	4863.52	1303.13	4861.46	1403.20	4859.45
1502.61	4857.55	1615.47	4856.30	1713.89	4854.34	1829.70	4853.68
1944.86	4854.43	2059.36	4854.34	2173.20	4854.43	2336.59	4855.39
2501.94	4856.30	2661.38	4857.62	2829.36	4857.95	2992.75	4859.16
3173.85	4859.95	3336.90	4860.93	3502.25	4861.55	3714.85	4863.16
3928.76	4864.84	4076.39	4865.52	4222.39	4866.74	4388.07	4868.61
5338.52	4877.83	5521.26	4879.57	5717.12	4881.57	5912.00	4883.83
4583.93	4870.51	4783.41	4872.51	4992.07	4874.74	5159.06	4876.35
6108.85	4886.29	6323.09	4889.02	6438.57	4890.36	6553.73	4891.87
8209.88	4916.64	9849.62	4942.75	11489.36	4970.35	12771.82	4992.49
13132.71	4998.92	14772.45	5028.48	15755.05	5046.46		

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PACIFIC OCEAN

P07

0.00	4952.66	91.53	4954.34	171.26	4955.55	271.32	4956.73
303.15	4958.40	337.27	4961.16	368.11	4962.44	383.85	4961.26
401.90	4959.49	417.97	4957.29	433.72	4950.79	449.80	4941.11
467.19	4934.98	484.57	4931.99	501.31	4930.39	517.71	4927.23
533.46	4924.45	549.53	4921.36	565.94	4914.80	582.34	4909.91
598.75	4905.84	614.82	4903.32	629.91	4902.24	647.30	4900.40
682.41	4898.92	729.98	4897.38	795.59	4895.38	862.52	4893.34
910.42	4890.59	942.90	4888.29	993.10	4885.27	1041.98	4883.11
1091.52	4880.75	1157.14	4878.06	1222.75	4876.02	1287.71	4873.73
1337.58	4871.63	1386.14	4868.54	1436.01	4865.49	1500.31	4862.61
1548.87	4859.91	1617.11	4857.22	1731.28	4854.40	1829.05	4852.20
1911.39	4850.17	2060.01	4848.82	2220.77	4849.05	2404.50	4851.05
2618.41	4852.66	2845.77	4854.83	2994.71	4856.01	3156.79	4856.11
3323.78	4858.08	3504.88	4859.88	3680.40	4861.03	3863.14	4862.67
4043.26	4864.61	4240.43	4866.57	4404.14	4868.12	4568.52	4869.30
4746.99	4871.04	4947.12	4872.81	5159.39	4875.07	5387.73	4877.73
5568.50	4879.57	5765.68	4881.54	5946.12	4883.73	6143.95	4886.39
6337.85	4888.92	6555.04	4891.84	8210.86	4916.28	9851.26	4942.52
11490.67	4970.08	12525.44	4988.13	13132.06	4998.92	14771.14	5028.32
16412.86	5058.40	17066.05	5070.48				

PACIFIC OCEAN

P08

0.00	4983.40	37.73	4983.86	55.12	4981.20	72.51	4977.63
88.91	4976.35	122.05	4974.48	139.11	4972.25	154.53	4969.23
169.95	4967.36	253.93	4966.18	351.37	4966.47	434.71	4967.69
581.69	4967.26	631.55	4965.88	677.81	4963.23	748.02	4961.98
794.94	4959.91	828.40	4958.70	860.55	4956.73	925.19	4954.76
1007.86	4953.02	1024.27	4951.19	1059.04	4948.14	1075.77	4944.89
1091.85	4940.46	1107.93	4937.05	1123.67	4933.60	1140.41	4931.99
1172.89	4929.80	1205.04	4927.86	1223.08	4926.09	1240.80	4924.12
1273.28	4921.36	1320.85	4919.30	1337.91	4917.59	1370.72	4914.67
1434.37	4912.41	1516.71	4910.64	1533.12	4909.03	1550.18	4906.27
1567.24	4903.88	1583.31	4901.12	1599.06	4899.45	1615.14	4896.92
1630.56	4894.33	1647.29	4890.56	1664.68	4888.16	1681.41	4889.90
1697.16	4892.59	1713.23	4893.80	1730.29	4893.80	1746.70	4892.33
1762.12	4889.41	1778.85	4883.67	1795.91	4877.99	1812.97	4874.41
1830.36	4871.40	1847.09	4869.04	1877.93	4866.38	1928.13	4868.87
1976.68	4867.69	2011.46	4865.33	2043.61	4863.39	2107.91	4860.73
2222.74	4858.80	2353.97	4857.52	2452.40	4856.54	2566.90	4857.42
2715.52	4856.18	2830.02	4856.14	2943.53	4856.27	3058.03	4855.98
3191.56	4856.50	3353.96	4856.57	3533.75	4858.44	3682.37	4858.86
3830.66	4859.42	3994.05	4860.93	4175.14	4862.31	4338.86	4863.95
4551.45	4866.05	4699.09	4867.59	4830.32	4868.97	4979.60	4870.74
5158.73	4872.97	5340.48	4875.14	5521.26	4877.46	5699.73	4879.66
5898.55	4882.29	6062.59	4884.49	6224.00	4886.79	6389.36	4889.21
6554.38	4891.54	8211.51	4916.11	9850.60	4942.49	11491.98	4970.18
13361.06	5002.73	14773.11	5027.96	16412.52	5057.61	18053.91	5087.80
19756.31	5119.59						

PACIFIC OCEAN

P09

0.00	4979.60	13.12	4979.83	37.07	4977.66	87.93	4977.17
101.38	4973.56	122.05	4969.63	139.76	4968.02	172.90	4966.38
204.72	4964.70	221.13	4963.32	236.55	4961.49	253.93	4959.88
287.07	4958.04	318.57	4955.88	353.01	4955.22	368.43	4953.45
383.20	4952.20	399.27	4950.96	417.32	4949.84	435.69	4947.51
451.44	4943.21	466.86	4939.54	482.61	4936.13	499.67	4931.86
516.73	4929.20	532.47	4926.75	582.34	4924.48	597.76	4923.10
614.82	4920.77	630.24	4917.75	645.33	4915.75	677.81	4913.69
712.59	4911.62	743.43	4909.95	760.82	4908.70	779.19	4906.34
795.92	4904.63	828.73	4901.84	860.55	4899.71	924.86	4897.71
940.61	4895.51	958.65	4892.46	976.69	4891.08	992.11	4879.34
1006.55	4866.38	1021.64	4854.37	1039.69	4841.31	1058.06	4836.23
1075.77	4833.60	1187.32	4832.91	1239.16	4829.60	1269.01	4830.29
1286.40	4831.73	1302.81	4834.68	1319.87	4836.23	1336.60	4836.72
1385.15	4834.75	1402.54	4832.32	1419.60	4830.29	1435.68	4831.11
1450.44	4836.23	1466.85	4840.36	1484.56	4843.21	1500.64	4849.91
1516.06	4860.01	1533.12	4866.18	1550.51	4867.46	1566.25	4862.18
1581.02	4854.47	1598.41	4849.81	1616.12	4848.04	1648.27	4851.22
1664.68	4856.18	1681.08	4860.54	1713.89	4863.03	1745.71	4860.67
1762.45	4856.63	1778.85	4854.17	1795.25	4847.74	1811.33	4841.02
1877.27	4838.55	1893.68	4838.00	1911.39	4840.49	1944.53	4840.03
1960.61	4842.56	1974.71	4843.68	1990.79	4841.84	2007.52	4840.03
2089.87	4838.43	2106.27	4839.34	2121.36	4840.52	2154.17	4843.57
2370.05	4845.51	2598.72	4847.51	2764.07	4849.15	2928.77	4849.41
3126.60	4850.46	3336.57	4852.27	3502.91	4852.50	3697.13	4854.24
3864.78	4856.37	4040.63	4858.21	4206.97	4859.65	4386.76	4861.95
4586.56	4864.14	4783.08	4866.67	4977.96	4868.87	5191.21	4871.50
5388.08	4873.50	5583.92	4876.22	5798.81	4879.34	5994.35	4881.93
6192.51	4884.75	6405.11	4888.03	6553.40	4890.23	8210.86	4915.13
9849.62	4941.87	11096.32	4962.77	11488.05	4969.66	13130.09	4998.73
14773.44	5027.89	16414.16	5057.61	18051.61	5087.77	19739.59	5119.26

PACIFIC OCEAN

P10

0.00	4940.10	39.37	4940.59	55.45	4940.49	70.54	4940.16
88.25	4936.32	104.66	4934.71	121.06	4930.88	136.81	4922.05
153.87	4917.16	171.26	4914.38	204.72	4911.72	220.14	4910.73
253.28	4908.11	303.47	4906.30	319.22	4904.60	334.97	4901.48
350.39	4899.41	367.12	4899.25	401.24	4896.17	417.97	4893.94
450.78	4892.30	466.53	4890.39	482.61	4888.23	516.07	4885.08
531.49	4882.48	546.91	4878.78	565.28	4876.55	597.43	4873.76
614.17	4872.05	629.59	4869.69	645.66	4867.43	662.72	4866.38
679.45	4869.86	694.87	4872.28	710.29	4874.35	729.32	4878.68
745.40	4880.58	778.86	4879.73	793.63	4878.16	811.67	4872.91
827.42	4868.41	844.48	4862.24	860.88	4857.19	877.29	4854.01
892.38	4852.79	908.78	4854.47	926.17	4857.52	942.25	4859.62
975.71	4861.06	992.11	4856.89	1008.52	4849.64	1024.92	4846.50
1073.48	4844.50	1090.87	4842.10	1107.93	4840.23	1124.33	4838.16
1139.09	4836.69	1154.84	4836.79	1172.23	4838.13	1207.01	4839.47
1239.49	4841.67	1255.89	4843.08	1270.65	4844.43	1286.73	4845.21
1384.17	4842.89	1449.79	4841.05	1500.31	4838.10	1630.56	4836.29
1712.91	4835.31	1745.06	4837.28	1780.49	4839.54	1828.39	4841.51
1861.53	4843.34	1878.26	4843.97	1910.08	4844.92	2091.84	4844.69
2157.78	4841.57	2287.70	4841.34	2433.70	4842.30	2565.59	4842.26
2732.58	4843.41	2911.05	4845.21	3092.15	4847.32	3271.94	4848.59
3468.46	4851.09	3667.61	4852.83	3880.20	4854.76	4076.07	4857.00
4271.93	4859.36	4470.75	4861.85	4684.00	4864.34	4862.47	4866.64
5043.25	4869.04	5240.42	4871.73	5421.52	4874.12	5602.62	4876.58
5798.81	4879.17	5978.60	4881.80	6177.09	4884.59	6357.21	4887.41
19726.46	5119.10	0.00	0.00	0.00	0.00	0.00	0.00
12984.09	4995.97	14771.47	5027.86	18411.21	5057.58	18051.61	5087.86
19726.46	5119.10						

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101

0.00	5055.05	3.28	5055.05	6.56	5055.05	9.84	5055.71
13.12	5055.38	19.68	5055.05	22.97	5055.05	29.53	5054.73
32.81	5054.40	36.09	5054.07	39.70	5053.74	42.98	5053.41
46.26	5053.41	49.54	5053.41	52.82	5053.41	56.10	5055.38
59.38	5053.41	62.66	5053.41	65.94	5053.41	69.22	5053.41
72.51	5053.41	75.79	5053.74	79.07	5053.41	82.35	5053.41
85.63	5053.74	88.91	5053.41	92.19	5053.41	95.47	5053.74
98.75	5053.74	102.03	5054.07	105.31	5053.74	108.59	5053.74
111.88	5053.74	118.44	5053.74	121.72	5053.74	125.33	5053.74
128.61	5053.41	135.17	5053.41	138.45	5053.41	141.73	5053.41
145.01	5053.41	148.29	5053.09	151.57	5053.09	154.85	5052.76
158.13	5052.76	161.42	5052.43	164.70	5052.43	181.10	5052.10
197.50	5052.10	214.24	5051.45	230.64	5050.13	247.04	5048.82
263.45	5048.50	279.85	5048.82	296.26	5048.82	312.99	5048.82
329.39	5049.15	345.80	5049.48	362.20	5049.48	378.60	5049.48
395.01	5048.50	411.74	5047.51	428.14	5045.87	444.55	5045.21
460.95	5043.57	477.36	5039.64	493.76	5019.30	510.16	5011.75
526.57	5001.25	542.97	4991.08	559.38	4980.91	576.11	4978.61
592.51	4971.07	608.92	4968.44	625.32	4963.20	641.72	4959.59
658.13	4955.32	740.15	4946.79	822.17	4940.88	903.86	4936.29
985.38	4930.06	1067.90	4927.11	1149.92	4927.43	1231.61	4923.82
1313.63	4922.18	1395.65	4921.53	1477.34	4922.84	1559.36	4926.45
1641.06	4923.50	1723.08	4930.06	1804.77	4932.03	1886.46	4921.20
1968.48	4915.95	2050.17	4915.95	2138.42	4918.25	2213.56	4918.90
2296.56	4920.21	2377.27	4920.54	2458.96	4921.53	2540.65	4935.96
2624.64	4935.96	2704.04	4930.71	2785.73	4925.79	2870.70	4917.59
2952.72	4916.93	3030.80	4913.32	3112.49	4911.36	3194.19	4909.72
3275.55	4908.73	3357.24	4908.08	3438.93	4905.78	3520.63	4905.45
3608.88	4906.11	3683.68	4904.47	3765.05	4902.83	3846.74	4902.83
3938.96	4902.17	4009.79	4902.83	4091.49	4904.47	4172.85	4905.13
4254.21	4903.81	4335.91	4903.81	4417.27	4903.81	4501.91	4908.08
4593.12	4906.44	4661.69	4905.78	4743.05	4903.48	4824.42	4900.53
4906.11	4898.89	4987.47	4898.89	5068.84	4899.55	5150.20	4899.88
5249.28	4898.89	5312.93	4897.25	5394.29	4894.95	5475.66	4895.94
5560.30	4895.61	5638.05	4895.94	5719.42	4895.94	5800.78	4894.30
5882.14	4894.95	5963.51	4895.28	6044.55	4895.28	6125.91	4895.94
6207.27	4895.94	6288.31	4896.59	6369.67	4897.25	6453.99	4897.91
6532.07	4898.56						

TABLE (XVI). Numerical values of sound speeds (in feet/sec) for SIMAS profiles

ATLANTIC OCEAN

A01

0.00	4965.95	108.30	4967.75	449.99	4961.95	699.99	4953.94
999.99	4945.94	1249.98	4939.93	1499.98	4935.93	1749.98	4931.93
1999.98	4929.93	2249.97	4929.93	2499.97	4930.95	2749.97	4931.93
2999.96	4933.93	3249.96	4936.95	3499.96	4939.93	3999.95	4945.94
4499.95	4942.95	4999.94	4936.95	5999.93	4928.94	6999.91	4926.94
8999.89	4948.96	11999.85	4994.95	14999.82	5043.93	17401.20	5083.93

A02

0 00	4965 95	449.99	4961.95	699.99	4953.94	999.99	4945.94
1249 98	4939.93	1499.98	4935 93	1749.98	4931.93	1999.98	4929.93
2249.97	4929 93	2499.97	4930.95	2749.97	4931.93	2999.96	4933.93
3249 96	4936.95	3499.96	4939.93	3999.95	4945.94	4499.95	4942.95
4999.94	4936.95	5999.93	4928.94	6999.91	4926.94	8999.89	4948.96
11999.85	4994.95	14999.82	5043.93	17718.28	5089.24		

A03

0 00	5007 00	65.90	5008.10	200.00	5002.00	250.00	4996.00
500 00	4982.00	750.00	4970.00	1000.00	4960.00	1250.00	4952.00
1500 00	4947.00	1750.00	4942.00	2000.00	4939.00	2250.00	4936.00
2500 00	4933.00	2750.00	4930.00	3000.00	4928.00	3250.00	4926.00
3500 00	4924.00	4000.00	4920.00	4500.00	4917.00	5000.00	4915.00
6000 00	4918.00	7081.80	4926.70				

A04

0 00	5034 70	24.60	5035.90	95.50	5008.30	209.00	4988 50
498 10	4986.70	752.30	4988.90	987.30	4991.80	1000.00	4992.00
1250 00	4994.00	1500.00	4992.00	1750.00	4985.00	2000.00	4973.00
2250 00	4958.00	2500.00	4940.00	2750.00	4923.00	3000.00	4909.00
3250 00	4900.00	3500.00	4893.00	4000.00	4888.00	4500.00	4891.00
5000 00	4896.00	6000.00	4908.00	7000.00	4921.00	9000.00	4949.00
12000 00	4995.00	15000.00	5044.00	18534.60	5102.90		

ATLANTIC OCEAN

A 05

0 00	5059 50	36.10	5060.10	196.90	5021.20	344.50	5001 90
492 10	4998.00	738.20	4997.40	1000.00	4999 00	1200.80	5000 30
1250 00	5000.00	1500.00	4998.00	1750.00	4994.00	2000.00	4985 00
2250 00	4970.00	2500.00	4953.00	2750 00	4937.00	3000.00	4922.00
3250 00	4911.00	3500.00	4902.00	4000.00	4892.00	4500.00	4891 00
5000 00	4896.00	6000.00	4908.00	7000.00	4921.00	9000.00	4949.00
12000 00	4995.00	15000.00	5044.00	18671.60	5105.20		

A 06

0 00	5056.90	88.60	5059.10	164.00	5032.50	344.50	5003.30
492 10	4998 50	738.20	4997.90	1000.00	4999.00	1200.80	4999 90
1250 00	5000 00	1500.00	4998.00	1750.00	4994.00	2000.00	4985.00
2250 00	4970.00	2500.00	4953.00	2750.00	4937.00	3000.00	4922.00
3250 00	4911.00	3500 00	4902.00	4000.00	4892.00	4500.00	4891.00
5000 00	4896.00	6000 00	4908.00	7000.00	4921.00	9000.00	4949.00
12000 00	4995.00	15000.00	5044.00	18671.90	5105.20		

PACIFIC OCEAN

P01

0.00	4951.84	78.71	4952.14	187.01	4896.33	295.30	4888.75
492.09	4872.64	748.09	4866.84	1000.68	4856.93	1249.98	4847.94
1499.98	4843.94	1749.98	4841.93	1999.98	4840.95	2249.97	4841.93
2499.97	4843.94	2749.97	4846.95	2999.96	4848.96	3249.96	4850.93
3499.96	4852.93	3999.95	4857.95	4499.95	4862.93	4999.94	4868.94
5999.93	4882.95	6999.91	4898.96	8999.89	4929.93	11999.85	4978.94
14999.82	5030.94	17893.97	5083.04				

#

P02

0.00	5014.93	78.71	5015.32	89.99	5015.13	200.00	4957.95
300.00	4942.95	499.99	4933.93	999.99	4917.95	1249.98	4904.93
1499.98	4889.93	1749.98	4875.93	1999.98	4865.95	2249.97	4858.93
2499.97	4854.93	2749.97	4853.95	2999.96	4855.95	3249.96	4856.93
3499.96	4858.93	3999.95	4863.95	4499.95	4868.94	4999.94	4873.96
5999.93	4884.95	6999.91	4898.96	8999.89	4929.93	11999.85	4978.94
14999.82	5030.94	17999.77	5084.95	19831.15	5119.75		

#

P03

0.00	4994.43	98.39	4988.03	196.91	4973.82	295.30	4967.85
502.00	4965.23	748.09	4962.34	994.08	4956.04	999.99	4955.94
1249.98	4940.95	1499.98	4923.96	1749.98	4905.95	1999.98	4888.95
2249.97	4877.93	2499.97	4871.95	2749.97	4866.93	2999.96	4864.93
3249.96	4862.93	3499.96	4861.95	3999.95	4862.93	4499.95	4866.93
4999.94	4871.95	5999.93	4883.93	6999.91	4898.96	8999.89	4929.93
11999.85	4978.94	14999.82	5030.94	17999.77	5084.95	19846.05	5120.05

#

P04

0.00	4974.94	59.09	4975.92	1249.98	4969.95	1499.98	4955.94
1749.98	4938.95	1999.98	4919.95	2249.97	4903.94	2499.97	4890.95
2749.97	4880.95	2999.96	4873.96	3249.96	4868.94	3499.96	4865.95
3999.95	4864.93	4499.95	4866.93	4999.94	4871.95	5999.93	4883.93
6999.91	4898.96	8999.89	4929.93	11999.85	4978.94	14999.82	5030.94
18584.39	5095.44						

#

PACIFIC OCEAN

P05

0.00	4938.95	19.68	4939.25	499.99	4919.95	749.99	4902.93
999.99	4886.95	1249.98	4868.94	1499.98	4858.93	1749.98	4852.93
1999.98	4849.94	2249.97	4847.94	2499.97	4847.94	2749.97	4847.94
2999.96	4848.96	3249.96	4849.94	3499.96	4851.94	3999.95	4857.95
4499.95	4863.95	4999.94	4869.95	5999.93	4883.93	6999.91	4898.96
8999.89	4929.93	11999.85	4978.94	14999.82	5030.94	18540.16	5094.62

P06

0.00	4927.73	8.89	4927.93	205.71	4930.02	401.90	4924.55
534.08	4905.25	748.09	4880.13	992.80	4865.33	999.99	4864.93
1249.98	4859.95	1499.98	4855.95	1749.98	4853.95	1999.98	4852.93
2249.97	4851.94	2499.97	4851.94	2749.97	4853.95	2999.96	4854.93
3249.96	4857.95	3499.96	4859.95	3999.95	4863.95	4499.95	4867.95
4999.94	4872.94	5999.93	4883.93	6999.91	4898.96	8999.89	4929.93
11999.85	4978.94	14999.82	5030.94	16324.00	5054.73		

P07

0.00	4958.44	74.51	4959.65	204.69	4961.75	401.90	4964.05
533.49	4930.95	729.98	4902.93	993.20	4890.23	999.99	4889.93
1249.98	4873.96	1499.98	4863.95	1749.98	4853.95	1999.98	4849.94
2249.97	4849.94	2499.97	4849.94	2749.97	4852.93	2999.96	4854.93
3249.96	4856.93	3499.96	4859.95	3999.95	4863.95	4499.95	4867.95
4999.94	4872.94	5999.93	4884.95	6999.91	4898.96	8999.89	4929.93
11999.85	4978.94	14999.82	5030.94	17279.28	5071.95		

P08

0.00	4972.94	2.00	4972.94	1499.98	4967.95	1749.98	4951.94
1999.98	4933.93	2249.97	4915.95	2499.97	4897.94	2749.97	4883.93
2999.96	4873.96	3249.96	4868.94	3499.96	4865.95	3999.95	4864.93
4499.95	4866.93	4999.94	4871.95	5999.93	4883.93	6999.91	4898.96
8999.89	4929.93	11999.85	4978.94	14999.82	5030.94	17999.77	5084.95
19860.94	5120.34						

PACIFIC OCEAN

P09

0.00	4972.94	1499.98	4967.95	1749.98	4951.94	1999.98	4933.93
2249.97	4915.95	2499.97	4897.94	2749.97	4883.93	2999.96	4873.96
3249.96	4868.94	3499.96	4865.95	3999.95	4864.93	4499.95	4866.93
4999.94	4871.95	5999.93	4883.93	6999.91	4898.96	8999.89	4929.93
11999.85	4978.94	14999.82	5030.94	17999.77	5084.95	19223.25	5108.14

P10

0.00	4972.94	70.90	4973.04	1499.98	4967.95	1749.98	4951.94
1999.98	4933.93	2249.97	4915.95	2499.97	4897.94	2749.97	4883.93
2999.96	4873.96	3249.96	4868.94	3499.96	4865.95	3999.95	4864.93
4499.95	4866.93	4999.94	4871.95	5999.93	4883.93	6999.91	4898.96
8999.89	4929.93	11999.85	4978.94	14999.82	5030.94	17999.77	5084.95
19223.25	5108.14						

INDIAN OCEAN

101

		LAT 04 49 N		LON 53 02 E		MARCH	
00	5047.40	82.40	5045.90	164.70	5045.10	329.40	5041.30
493 80	5019.00	740 20	4941.20	1000.00	4928.00	1150.00	4920.40
1250 00	4922.00	1500.00	4921.00	1750.00	4920.00	2000.00	4920.00
2250 00	4919 00	2500.00	4917.00	2750.00	4915.00	3000.00	4913.00
3250.00	4911.00	3500.00	4910.00	4000.00	4906.00	4500.00	4903.00
5000 00	4902.00	6000.00	4904.00	7000.00	4908.00	9000.00	4931.00
12000.00	4978 00	15000.00	5025 00	17550.00	5072.60		

TABLE (XVII). Numerical values of sound speeds (in feet/sec) for ICAPS profiles

ATLANTIC OCEAN

A 01

0.00	4955.65	137.79	4956.63	337.92	4959.91	383.85	4956.63
433.07	4946.13	511.80	4942.52	567.58	4939.90	652.88	4940.23
708.65	4937.61	725.06	4939.25	741.48	4938.26	800.52	4941.54
971.12	4934.00	997.36	4936.95	1049.86	4934.00	1079.38	4932.36
1095.79	4934.98	1377.94	4933.67	1525.57	4932.68	1968.48	4932.36
2624.64	4937.93	3280.80	4942.20	3936.96	4943.18	4921.20	4929.07
6561.60	4924.15	8202.00	4939.57	9842.40	4961.55	13123.20	5013.72
16404.00	5071.79	17125.77	5084.91				

*

A 02

0.00	4953.68	154.20	4954.99	232.94	4954.01	311.68	4954.34
406.82	4954.66	439.63	4952.04	469.15	4946.79	567.58	4941.21
688.97	4940.88	754.58	4943.18	853.01	4939.25	1115.47	4934.32
1328.72	4934.00	1525.57	4933.67	1968.48	4933.34	2624.64	4938.59
3280.80	4942.85	3936.96	4943.51	4921.20	4929.40	6561.60	4924.15
8202.00	4939.57	9842.40	4961.88	13123.20	5013.72	16404.00	5071.79
17913.17	5099.02						

*

A 03

0.00	5008.14	22.97	5008.47	65.62	5009.13	88.58	5003.55
108.27	4982.55	154.20	4974.68	200.13	4984.83	246.06	4960.24
436.35	4954.99	675.84	4952.37	997.38	4944.18	1643.68	4933.34
2490.13	4917.26	3280.80	4905.13	3936.96	4902.83	4921.20	4902.83
6561.60	4917.59	8202.00	4939.57	9842.40	4961.88	13123.20	5011.75
13418.47	5016.67						

*

A 04

0.00	5056.03	36.09	5036.68	52.49	5029.14	72.18	5022.91
95.14	5010.11	121.39	5002.89	147.64	4996.98	206.69	4991.08
282.15	4987.80	948.15	4993.05	1115.47	4986.00	1210.62	4997.64
1361.53	4991.08	1706.02	4978.94	1994.73	4965.82	2526.22	4935.30
3280.80	4896.59	3936.96	4888.39	4921.20	4895.61	6561.60	4916.61
8202.00	4940.55	9842.40	4983.85	13123.20	5012.08	16404.00	5068.84
17716.32	5091.80						

*

ATLANTIC OCEAN

A05

0.00	5059.65	65.62	5059.65	82.02	5059.32	104.99	5057.02
203.41	5020.28	249.34	5012.73	328.08	5004.53	426.50	5000.59
708.65	4999.61	935.03	5000.27	1089.23	5000.59	1230.30	5001.91
1312.32	5002.23	1482.92	5001.91	1706.02	5000.59	1902.88	4993.38
2099.71	4982.55	2230.94	4977.98	2378.58	4968.11	2493.41	4961.88
3280.80	4914.96	3936.96	4899.55	4921.20	4901.52	6561.60	4919.23
8202.00	4940.88	9842.40	4962.87	13123.20	5012.73	16404.00	5069.16
17519.47	5088.85						

\#

A06

0.00	5057.35	59.05	5058.66	88.58	5060.30	164.04	5034.39
252.62	5012.73	344.48	5005.52	492.12	5000.59	1640.40	5002.56
1843.81	4998.30	2099.71	4985.50	2624.64	4953.68	3280.80	4914.64
3936.96	4899.22	4921.20	4901.52	6561.60	4919.23	8202.00	4940.55
9842.40	4962.87	13123.20	5012.73	16404.00	5069.16	17519.47	5088.85

\#

PACIFIC OCEAN

P01

0.00	4954.34	108.27	4950.40	137.79	4919.23	157.48	4905.13
255.90	4899.22	285.43	4894.95	324.80	4888.72	374.01	4878.88
423.22	4871.33	521.65	4881.17	659.44	4877.89	787.39	4871.00
974.40	4863.79	1200.77	4853.29	1318.88	4849.68	1515.73	4845.09
1968.48	4842.79	2624.64	4846.07	3280.80	4851.32	3936.96	4857.55
4921.20	4869.04	6561.60	4891.34	8202.00	4916.28	9842.40	4942.52
13123.20	4998.95	16404.00	5058.34	17749.13	5082.94		

P02

0.00	5005.19	127.95	5005.52	157.48	4998.95	196.85	4961.88
265.74	4936.95	344.48	4914.64	442.91	4907.75	511.80	4907.75
629.91	4913.32	757.86	4909.72	984.24	4901.84	1151.56	4895.94
1318.88	4888.72	1515.73	4878.22	1968.48	4864.77	2624.64	4861.49
3280.80	4863.13	3936.96	4864.44	4921.20	4873.96	6561.60	4892.33
8202.00	4916.28	9842.40	4942.85	13123.20	4998.95	16404.00	5058.34
17978.79	5087.54						

P03

0.00	4999.61	39.37	4996.66	68.90	4995.34	78.74	4994.69
137.79	4986.82	196.85	4979.27	383.85	4971.72	561.02	4970.41
748.02	4967.13	1053.14	4958.27	1309.04	4945.80	1515.73	4932.03
1968.48	4893.97	2624.64	4864.44	3280.80	4859.52	3936.96	4861.49
4921.20	4872.32	6561.60	4891.34	8202.00	4915.95	9842.40	4942.52
13123.20	4998.63	16404.00	5057.68	19192.68	5108.53		

P04

0.00	4945.15	78.74	4945.48	167.32	4943.51	285.43	4937.93
413.38	4928.75	600.39	4920.21	718.50	4910.37	836.60	4900.53
1141.72	4880.19	1318.88	4883.79	1515.73	4856.24	1968.48	4845.09
2624.64	4844.43	3280.80	4849.02	3936.96	4855.25	4921.20	4867.07
6561.60	4889.70	8202.00	4914.64	9842.40	4941.87	13123.20	4998.63
16404.00	5057.02	17978.79	5085.57				

PACIFIC OCEAN

P05

0.00	4953.35	344.48	4949.74	590.54	4942.85	787.7'	4925.46
954.71	4913.00	1181.09	4897.25	1318.88	4888.06	1515.73	4877.24
1968.48	4858.54	2624.64	4853.29	3280.80	4855.91	3936.96	4860.18
4921.20	4869.69	6561.60	4890.69	8202.00	4914.96	9842.40	4941.54
13123.20	4998.30	16404.00	5057.35	17978.79	5085.89		

P06

0.00	4929.40	206.69	4932.03	272.31	4931.04	334.64	4924.81
370.73	4926.45	403.54	4927.43	469.15	4912.01	534.77	4909.06
600.39	4901.19	666.00	4890.69	731.62	4884.78	793.95	4880.85
862.85	4875.93	928.47	4873.30	990.80	4870.68	1059.70	4868.05
1122.03	4865.10	1190.93	4863.79	1253.27	4862.14	1318.88	4860.83
1387.78	4859.19	1450.11	4857.88	1502.61	4857.22	1968.48	4853.61
2624.64	4855.25	3280.80	4858.86	3936.96	4863.79	4921.20	4873.30
6561.60	4892.66	8202.00	4916.61	9842.40	4942.85	13123.20	4999.28
16174.34	5052.43						

P07

0.00	4949.41	272.31	4953.02	318.24	4955.98	367.45	4958.93
403.54	4955.65	465.87	4933.01	534.77	4923.82	600.39	4905.78
666.00	4899.22	731.62	4896.92	797.23	4894.63	862.85	4893.31
925.19	4889.38	994.08	4884.45	1056.42	4881.83	1122.03	4879.21
1190.93	4876.58	1256.55	4875.27	1322.16	4872.64	1384.50	4868.38
1499.33	4862.47	1968.48	4857.88	2624.64	4858.54	3280.80	4860.83
3936.96	4865.43	4921.20	4874.29	6561.60	4892.98	8202.00	4916.93
9842.40	4942.85	13123.20	4999.28	16797.70	5063.26		

P08

0.00	4985.54	36.09	4984.19	55.77	4980.91	72.18	4977.30
137.79	4972.71	200.13	4968.15	469.15	4967.46	531.49	4967.46
793.95	4960.57	925.19	4955.32	990.80	4955.32	1059.70	4948.76
1125.31	4934.32	1322.16	4920.21	1502.61	4912.34	1968.48	4881.50
2624.64	4849.35	3280.80	4845.09	3936.96	4851.97	4921.20	4864.11
6561.60	4889.38	8202.00	4914.96	9842.40	4942.20	13123.20	4998.63
16404.00	5057.35	17978.79	5086.55				

PACIFIC OCEAN

P09

0.00	4979.27	13.12	4979.60	36.09	4976.97	68.90	4976.64
101.70	4973.36	141.07	4967.13	203.41	4964.18	400.26	4951.05
531.49	4927.11	597.11	4922.51	659.44	4914.31	725.06	4910.37
793.95	4904.47	859.57	4899.22	921.90	4896.59	990.80	4879.21
1059.70	4837.21	1253.27	4831.96	1318.88	4837.54	1450.11	4836.88
1499.33	4850.34	1968.48	4840.82	2624.64	4843.77	3280.80	4850.00
3936.96	4856.57	4921.20	4868.71	6561.60	4891.34	8202.00	4916.28
9842.40	4942.85	13123.20	4999.28	16404.00	5058.01	17978.79	5087.21

¤

P10

0.00	4940.55	68.90	4940.55	104.99	4934.98	137.79	4922.18
203.41	4912.01	400.26	4897.58	531.49	4883.14	597.11	4873.96
662.72	4867.07	695.53	4872.97	728.34	4878.88	761.15	4880.85
793.95	4878.88	859.57	4857.80	892.38	4852.96	925.19	4857.55
990.80	4857.55	1122.03	4839.18	1253.27	4842.79	1318.88	4844.10
1384.50	4843.77	1450.11	4842.13	1499.33	4838.85	1968.48	4835.24
2624.64	4838.52	3280.80	4842.79	3936.96	4851.64	4921.20	4864.44
6561.60	4888.72	8202.00	4914.64	9842.40	4941.87	13123.20	4998.30
16404.00	5058.01	17978.79	5087.21				

¤

INDIAN OCEAN

101

0.00	5056.70	157.48	5054.40	246.06	5050.79	393.70	5019.81
459 31	5011.89	475.72	5041.93	492.12	5026.84	524.93	5004.20
577 42	4981.89	626.63	4966.80	659.44	4958.93	823.48	4913.51
1394 34	4922.84	1476.36	4919.23	1558.38	4927.11	1640.40	4924.48
1722 42	4931.04	1804.41	4932.36	1886.46	4925.14	1968.48	4916.28
2050 50	4916.61	2139.08	4919.23	2214.54	4919.23	2296.56	4920.54
2378 58	4919.56	2460.60	4922.18	2539.34	4936.29	2624.64	4936.62
2785 40	4927.43	3280.80	4920.87	3936.96	4914.64	4921.20	4905.78
6561.60	4907.09	8202.00	4923.17	9842.40	4946.46	13123.20	4998.63
16404 00	5054.40						

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PART (II)

"EVALUATION OF THE SIMAS AND ICAPS ENVIRONMENTAL DATA BASE, DATA HANDLING PROCEDURES AND MERGE METHODOLOGY"

I. INTRODUCTION

The SIMAS (Sonar In-situ Mode Assessment System) and ICAPS (Integrated Command ASW Prediction System) environmental data bases are both being developed and available to APP. Each system has been designed and developed by different Navy activities and address different system applications. The common denominator between SIMAS and ICAPS is that both utilize an environmental data base of oceanographic parameters, both rely on an in-situ XBT (expendable bathythermograph) as input, and both have been developed as "on-board" prediction systems.

As requested by the APP Data Base Manager, NORDA 321 has been tasked to identify, as much as possible the reason(s) for the "significant" differences in the final computed sound speed profiles from previous SIMAS and ICAPS comparisons. In this portion of the report, the test comparisons and evaluations designed to identify the specific cause(s) or reason(s) for differences between the SIMAS ICAPS computed sound speed profiles are discussed.

II. BACKGROUND

In FY-79, a study ("comparison of the ICAPS and SIMAS Historical Environmental Data Base", by E. Hashimoto, dated 28 September 1979), was conducted to compare the SIMAS and ICAPS computed sound speed profiles at selected geographical locations, for a particular season or month. From this point, that report will herein be referred to as the **NORDA TM No. 66.** The purpose of that study was to present and compare any "significant" differences found between the SIMAS and ICAPS final computed sound speed profiles. The evaluation and cause for differences found specifically was not to be addressed in that study.

Since "significant" differences were found in the final computed vertical sound speed profiles, NAVSEA 06H4 and NORDA 534 (during an APP sponsored meeting on 21 Feb 1980) tasked NORDA 321 to conduct follow-on studies to evaluate the ability for SIMAS and ICAPS to reproduce real or assumed oceanography, and identify the cause(s) for previous differences. Part I of this report presented the ability of SIMAS and ICAPS to reproduce the assumed oceanography by using input temperature data from very accurate CTD (continuous-temperature-depth) or STD (salinity-temperature-depth) recorders.

The identification of possible cause(s) or reason(s) for previous differences found between the SIMAS and ICAPS computed vertical sound speed profiles will now be presented and discussed.

III. APPROACH USED IN THIS STUDY

In order for the author to properly determine or reasonably explain the "probable" cause(s) associated with the environmentally "significant" differences found in the APP FY-79 Task #2 Report, a very large effort was placed towards understanding several key areas:

- The review of all related documentation considered relevant to the profile generation process for each system (i.e., technical reports, software coding, etc.).
- Personal conversations with cognizant individuals at the Naval Underwater Systems Command (NUSC - E. Podeszwa, Code 3351) and the Naval Oceanographic Office (NOO - P. Moresdorf, Code 9200).
- The identification of the sources for the oceanographic data used in the development of each historical base.
- The identication of the analysis procedure(s) used in the selection of historical sound speed profiles.
- The identification of the spatial and temporal resolutions used in each system.
- The identification and influences of the external and internal methodology employed by each system regarding the handling of in-situ XBT data
- The identification and influence of the selection criteria and retrieval procedures for the proper historical sound speed profile.
- The identification and influence of the merging techniques employed when combining the in-situ XBT with the historical deep profile.
- The identification and influence of the different sound speed equations.

The author had requested assistance from the Ocean Data Systems, Inc. Rockville, MD (Mr. J. Locklin and Mr. B. W. Scaife). This request was approved by the APP Data Base Manager. ODSI was requested to provide supportive in-depth investigations as required.

IV. THE STUDY

This section will describe the specific work conducted and material considered to properly address the issues presented in section III. In order to assist the reader in understanding the various investigations conducted, this section has been divided into several categories.

- differences in philosophies
- differences in Input BT data handling procedures
- differences in the historical environmental data base composition
- differences in the merge methodology of BT to historical
- differences in the application of salinity
- differences in the sound speed equations
- differences in the software program coding errors

A. *Philosophies*

There appears to be fundamental differences between ICAPS and SIMAS in their basic conceptual philosophies:

SIMAS = The entire SIMAS philosophy rests on the integrity of the historical sound speed profiles in the environmental data base.

ICAPS = The entire ICAPS philosophy rests on the integrity of the *in-situ* BT.

B. *INPUT BT DATA HANDLING PROCEDURES*

Both SIMAS and IGAPS utilize, as an initial in-situ input, a BT (bathythermograph) trace. Each system attempts to capture the salient features in the temperature profile by inputting selected pairs of depth and temperature along the trace. Although the philosophy to utilize an in-situ BT observation are similar, each system employs a different subjective procedure which determines what pairs of depths and temperatures will be used as input.

The following are brief descriptions on the BT data handling procedures employed by each system:

- SIMAS

Certain "significant" points of inflection along each BT profile are marked or noted by the SIMAS operator. These certain "significant" points of inflection are selected according to how well they (the observed data points) group themselves in a more or less a linear fashion (personal conversation with G. Brown, NUSC). The determination in the degree of linearity of the data points along a BT trace is accomplished by using a straight edge (i.e., ruler) to line up any data points which fall along the straight edge. While proceeding down the trace, if the linear distribution and direction of the observed data points should change, the straight edge is then reoriented in a new, different direction (personal conversation with G. Brown, NUSC). An example of this process is illustrated on figure 1. According to the personnel who have designed the SIMAS system, they prefer that the maximum number of inflection points be held to 7 points per input BT trace. As a result, all data points describing a given BT may not be inputted into SIMAS (e.g., if profile has 12 inflection points and a maximum of 7 are selected, your significant points could be omitted).

• ICAPS

Certain "significant" points of inflection along each BT profile are marked or noted by the ICAPS operator. The first depth-temperature pair inputted into ICAPS is the surface and the surface temperature. The remaining pairs of depth-temperature are selected by the operator according to inflection which exist in each BT trace where sudden changes in trend (positive to negative, negative to positive) or gradient (numerical value per unit depth) occur. The numerical values of depth-temperature must actually occur and be contained on the BT trace. All values inputted are observed values.

C. Historical Environmental Data Base Composition

Both environmental data bases have been developed using the ocean station data observations at the National Oceanographic Data Center (NODC).

Each system utilizes an environmental data base in two modes: with an in-situ XBT, or without an in-situ XBT (pure historical). Briefly presented below are the parameters on file and available in SIMAS and ICAPS:

	SIMAS	ICAPS	COMMENTS
Temperature	NO	YES	ICAPS Temperature profiles are surface to bottom.
a) monthly	NO	NO	
b) seasonally averaged	NO	YES	ICAPS Temperature profiles are seasonal surface to bottom.
c) annual	NO	NO	
Salinity	NO	YES	SIMAS uses a constant salinity 35 ppt surface to the bottom.
a) monthly	NO	NO	ICAPS salinity profiles are seasonal surface to bottom.
b) seasonally averaged	NO	YES	
Density	NO	NO	
a) monthly	NO	NO	
b) seasonally	NO	NO	
Sound speed	YES	NO	ICAPS computes all values of sound speed
a) monthly	YES	NO	
b) seasonally	NO	NO	SIMAS sound speed profiles are surface to bottom.

Bathymetry

In addition to sound speed, temperature and salinity, there is another parameter which is common to both SIMAS and ICAPS. This parameter is bathymetry (ocean bottom depth). Briefly described below are the characteristics and sources for the bathymetry used in each system:

- ICAPS (HEATON-NOO)

  Automated, bathymetric depths recorded on the data files are those of the deepest identifiable bathymetric contour interval found in each 1/4-quadrangle (every 1/2° x 1/2° square or 30' x 30').

Source:

- North Atlantic and Mediterranean in Naval Oceanographic Office Special Publication #1304, 1975 (Confidential)
- North Pacific is Naval Oceanographic Office Special Publication #1301-2-3, 1973 (Confidential).
- North Indian Ocean is NMPCB Charts, Second Edition.

o SIMAS (Podeszwa - NUSC)

Manual point or area extraction off bathymetric contour charts.

Source:

- North Atlantic and Mediterranean is Naval Oceanographic Office Special Publication #1304, 1975 (Confidential)
- North Pacific is Naval Oceanographic Office Special Publication #1301-2-3, 1973 (Confidential).
- North Indian Ocean is NMPCB Charts, Second Edition.

D. MERGE METHODOLOGY

Each system computes sound speed as a final parameter. However, a basic difference exists in the manner in which SIMAS and ICAPS each merge to the In-situ BT observation. The basic different is merging to a sound speed profile or merging to a temperature profile.

An outline description of the differences in the ICAPS and SIMAS methodology of generating sound speed profiles is illustrated below:

METHODOLOGICAL FEATURES OF SSP GENERATOR (ODSI)

ICAPS	SIMAS
Multiple water mass (up to 5) capability for each geographic area.	A geographic area is represented by one water mass.
Historical data base contains for each water mass, temperature and salinity profiles (ZH_i, TH_i, SH_i), $i=1$, $NH \leq 45$.	Historical data base contains for each water mass a sound speed profile (ZH_i, VH_i), $NH \leq 27$, and a representative near-surface salinity value , S.
Extend the Bathythermograph (BT) profile, (ZB_i, TB_i), $j=1$, NBT, with historical temperatures for corresponding water mass at depth below the last BT depth, and interpolate salinity values from historical profile.	Utilize Leroy's equation to calculate the SSP for BT profile with historical constant salinity. The BT profile may consist of up to 24 points.
Insert bathymetry and truncate SSP at bottom depth.	Shift the BT SSP by the linearly interpolated velocity difference between historical SSP and BT SSP at 1000 ft. Next, extend below the BT SSP with unmodified historical SSP points.
Utilize Wilson's equation to calculate SSP.	Insert bathymetry and truncate SSP at bottom depth.
Calculate the layer depth.	Adjust fathometer bathymetry and interpolate sound speed at adjusted bottom depth.
	Calculate the layer depth.

Graphical presentations of the above outline description are given in the Logic Flow Diagrams of Appendix (A) and (B) for SIMAS and ICAPS, respectively.

- ICAPS = The numerical values of temperature from the In-situ BT observation are inputted into various sets of temperature criteria (as explained in Appendix (B)). After the in-situ BT profile has met certain established temperature criteria, it is *merged* with an analyzed seasonal *temperature* profile contained in the ICAPS environmental data base (see Appendix G). This merge temperature profile is then, inputted along with an analyzed seasonal salinity profile into Wilson's equation A derived sound speed profile is then computed. At no time is the BT profile rejected or not used once it is inputted into the ICAPS system.
- SIMAS = The numerical values of temperature from the in-situ BT observation, along with a constant salinity profile (value of 35.00 parts per thousand), are both entered into Leroy's equation. A derived sound speed profile is then inputted into various sets of sound speed criteria (as explained in Appendix (A)). After the derived sound speed profile has met certain established sound speed criteria, it is *merged* with an analyzed monthly averaged *sound speed* profile contained in the SIMAS environmental data base. If the derived sound speed profiles does not meet the sound speed criteria, it is possible for that particular BT observation and the derived sound speed profile to be *rejected* and *not used* for failure to meet the criteria.

  Upon rejection of an insitu XBT, a revised sound speed profile is computed. This revised sound speed profile is basically a modification of the SIMAS historical sound speed profile. According to investigations by Locklin and Scaife (ODSI), the historical SIMAS sound speed profile is revised as follows:

  1. The value of the surface sound speed from the historical profile is used.

2. The value of the sound speed at the layer from the historical profile is used.
3. The value of the depth of the layer is revised: depth of the layer becomes the value of the second depth point off of the XBT trace. In other words, the new depth of the layer is the depth of the XBT layer.
4. Values of sound speed below the revised layer depth are those from the historical sound speed profile.

- *Differences caused by different merging techniques*

As stated above (and described in Appendix (B)) ICAPS does not reject the in-situ BT at any time. The values of temperature at the surface and and of temperature and depth at the boundary of the surface layer are inputted into ICAPS and maintained unaltered throughout ICAPS processing. SIMAS on the other hand will reject the entire BT if the sound speed criteria is not met. Upon rejection of a BT, the SIMAS system generates a revised sound speed profile for use. Below is a comparison of the differences in surface sound speeds and layer depths due to the different merging techniques when using identical BT as input. The major differences, as noted by an asterisk (*) are cases where SIMAS rejected the in-situ BT data and computed revised sound speed profiles. The sites (1C, 1F, 1F, etc. are test sites from Fig. 2 (taken from NORDA TM #66).

ICAPS AND SIMAS LAYER DEPTHS AND
SURFACE SOUND SPEEDS USING
IDENTICAL BT AND HISTORICAL PROFILES
(DIFFERENCES CAUSED BY MERGING)

	ICAPS		SIMAS	
Site	Layer Depth (ft)	Surface Sound Speed (ft/sec)	Layer Depth (ft)	Surface Sound Speed (ft/sec)
1C	469.2	4964	469.2	4943*
1F	357.6	4910	357.6	4881*
1F	65.6	4936	65.6	4944
2A	85.3	5046	85.3	5038*
2E	3281.0	4903	1220.5	4909
2E	72.2	4987	72.2	4982
2H	420.0	4912	52.5	4798*
3A	59.1	5059	59.1	5063

o *The historical sound speed profiles for both SIMAS and ICAPS were computed by the National Oceanographic Data Center (NODC) using Wilson's equation. Although ICAPS elects to continue using Wilson's equation during the conversion of the in-situ BT profiles to a sound speed profile, SIMAS switches to Leroy's equation for its conversion to a sound speed profile.*

E. *APPLICATION OF SALINITY*

Each system employs different approaches in their application of salinity to the computation of sound speed. Obvious differences exist. For example, SIMAS uses a constant value of 35.00 parts per thousand (surface to the bottom) and ICAPS uses a seasonally averaged profile (surface to bottom). Although the applications of salinity differ, tests were conducted in an attempt to address the effects on the values of sound speed caused by the two different approaches. The effects on sound speed comparing constant salinity with variable and average salinity compared with 35.00 PPT salinity are presented in tables (I) and (II) respectively.

F. Sound Speed Equations

Common to both the SIMAS and ICAPS environmental data outputs is a vertical sound speed profile. The values of the SIMAS sound speeds profiles <u>may</u> differ from the ICAPS sound speed profiles because of the following:

	Equation used to compute sound speeds
SIMAS	Leroy's Equation
ICAPS	Wilson's Equation

(Leroy) $\frac{dv}{ds} = 1.2 - 0.01(T-18)$ (equation applicable for salinities 30-40 PPT and temperatures 0-30°).

(Wilson) $$\frac{dv}{ds} = 1.398 + 3.384 \times 10^{-3}(S-35) - 1.12 \times 10^{-2}T + 7.70 \times 10^{-5}P + 7.77 \times 10^{-2}T^2 - 1.29 \times 10^{-7}P^2 + 3.16 \times 10^{-8}PT + 1.58 \times 10^{-9}PT^2$$

where v = sound speed (meters/sec)

s = salinity (PPT)

T = temperature (°C)

Table (IV) is taken from "An Examination of the Sensitivities of Acoustic Performance Prediction (APP) High Level Products to Variations in the Marine Environment", by P. Etter and D. R. Erwin, MAR Technical Report #243, April 1980, (SECRET). In the opinion of the author, based on previous work performed by Mr. Paul Etter (MAR Incorporated), the differences in the values of sound speed due to the differences between Leroy's and Wilson's equations are very small and not significant.

G. *Software Coding Errors or Problem Areas*

During their supportive investigation, ODSI had noticed some programming errors in the ICAPS and SIMAS computer codings. The specific errors uncovered for ICAPS and SIMAS have been documented by ODSI and are described in Appendix (C) and (D). Presented below from each system are a few selected program errors which are considered noteworthy:

Significant SIMAS Coding Errors:

1) Metric unit inputted data are converted at least twice into English units (i.e., 5 meters/second converted to 16.4 feet/second then reconverted (16.4 m/s x 3.3) to 52.6 feet/second).
2) Erroneous determination of the layer depth by execution of a DO Loop causing erroneous results, see appendix (C).

Significant ICAPS Coding Errors:

1) When the use of metric units are not specified, the historical bathymetry in meters in incorrectly multiplied by feet-to-meter conversion factor, see appendix (D).

Program "cautions" where potential errors can occur are contained on Appendix (E) and (F).

Coding errors described in Appendix C-F have been pointed out and presented to SIMAS (NUSC) and ICAPS (NOO) as this study was still taking place. The errors may have already been corrected by each system and if so, did not affect the results of this study.

H. Cause(s) of "significant" differences in the SIMAS and ICAPS sound speed profiles found in NORDA Technical Note #66.

In an attempt to determine the cause of the "significant" difference found in the sound speed profiles of NORDA TN No. 66 titled, "Comparison of the ICAPS and SIMAS Historical Environmental Data Bases", by F. Hashimoto, dated 28 September 1979, there were eight (8) sites randomly selected from that study for sampling. Each of the eight sites were evaluated. Evaluations by J. Locklin, B. Scaife (Ocean Data Systems, Inc.) were conducted to determine the degree of influence caused by the merge algorithm, the historical profile, the bathythermograph data or by the salinity. Table (III) below represents a matrix showing the relative significantly of each factor at each site location:

Site	Merge Algorithm	Historical Profile	Bathythermograph Data	Salinity Variation	Location
1C*	Dominant		Slight		33.0°N, 172.5°W
1F*	Dominant		Slight		42.0°N, 143.5°W
1F	Dominant		Slight	Slight	same as above
2A*	Dominant	Moderate			13.0°N, 38.0°W
2E	Moderate	Dominant		Slight	47.5°N, 17.5°W
2E	Moderate	Dominant	Moderate		same as above
2H*	Dominant	Moderate			39.5°N, 68.5°W
3A*	Dominant				37.5°N, 17.5°E

TABLE III QUALITATIVE SIGNIFICANT CAUSE OF DIFFERENCES IN SIMAS vs ICAPS COMPARISONS (ODSI)

* In these SIMAS generated results, the BT data is considered as probable errored data, so that the generated profile is the historical profile with a layer depth revision.

V. DISCUSSION

If one were to glance at both the ICAPS and SIMAS systems, one could conceivably conclude that both are extremely similar and do not differ significantly. This conclusion can be reached when the following are lightly considered:

- Both ICAPS and SIMAS have an environmental data base
- Both ICAPS and SIMAS utilize In-situ BT data as input
- Both compute a final sound speed profile
- Both are designed for "on-board" and "on-scene" prediction systems

Although both systems have and do all of the above, closer investigations, as presented in section IV and in the Appendixes, show that significant basic differences do exist and strongly indicate that the ICAPS and SIMAS systems are, indeed, not identical and do differ markedly in some areas.

The major areas where each system differ markedly are:

- in their philosophies, as described in section IV (A)
- in their handling of the In-situ BT data INPUT profile, as described in section IV (B)
- in the historical environmental data bases, as described in section IV (C)
- in their merge methodologies of BT to the historical profile, as described in section IV (D).

The areas where differences exist but do not appear to be significant are:

- in the application of salinity (between approximately 34.50 PPT to 36.00 PPT above 1000 feet).
- in the sound speed equations

The areas where immediate improvements can be made are.

- in bathymetry, through the use of a larger, more recent, higher resolution, automated data set of bathymetry. See Appendix (G) for description and details regarding resolution and coverage of SYNBAPS by Mr. R. VanWyckhouse (NORDA).
- in the historical temperature, salinity and sound speed profiles through use of a larger (XBT, AXBT and BT) more recent (up to 1979), vertically stable, monthly temperature, seasonal salinity and

monthly sound speed data fields. Excerpts from the Pacific Sierra Research, Corp. (PSR) Report #922, "Evaluation of Standard Ocean Candidates", by J. Colborn, S. C. Daubin, Jr., E. Hashimoto, and F. J. Ryan, March 1980, describing the Generalized Digital Environmental Model by T. Davis (NOO) are presented in Appendix (H).

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AD-A124 096 APP FY-80 TASK I AND II REPORT(U) NAVAL OCEAN RESEARCH AND DEVELOPMENT ACTIVITY NSTL STATION MS E HASHIMOTO 30 SEP 80 NORDA-TN-69 2/2

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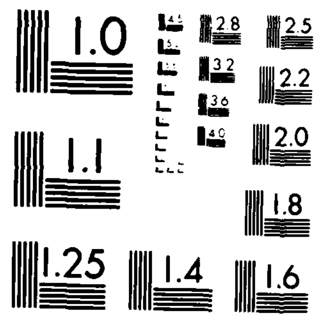


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

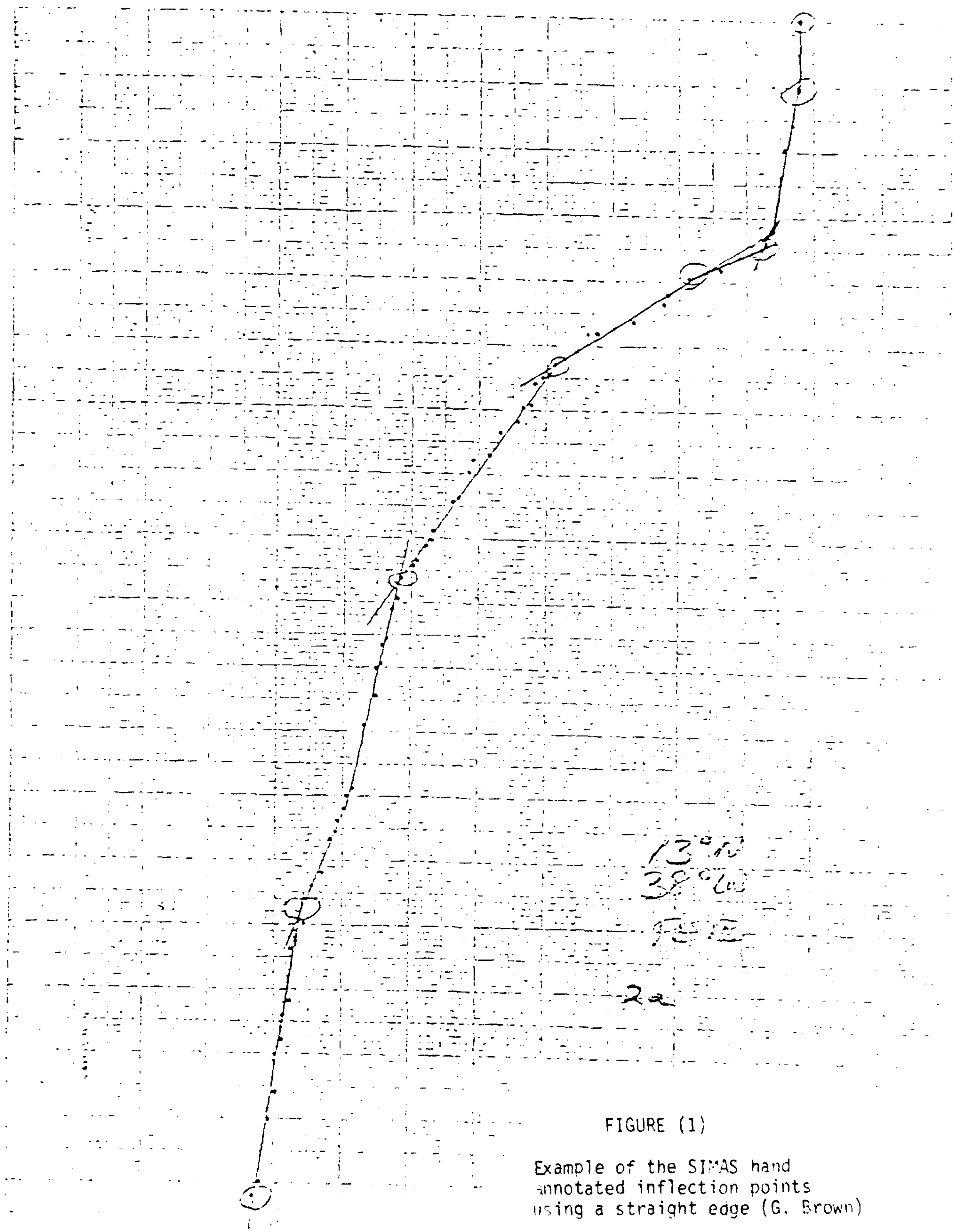
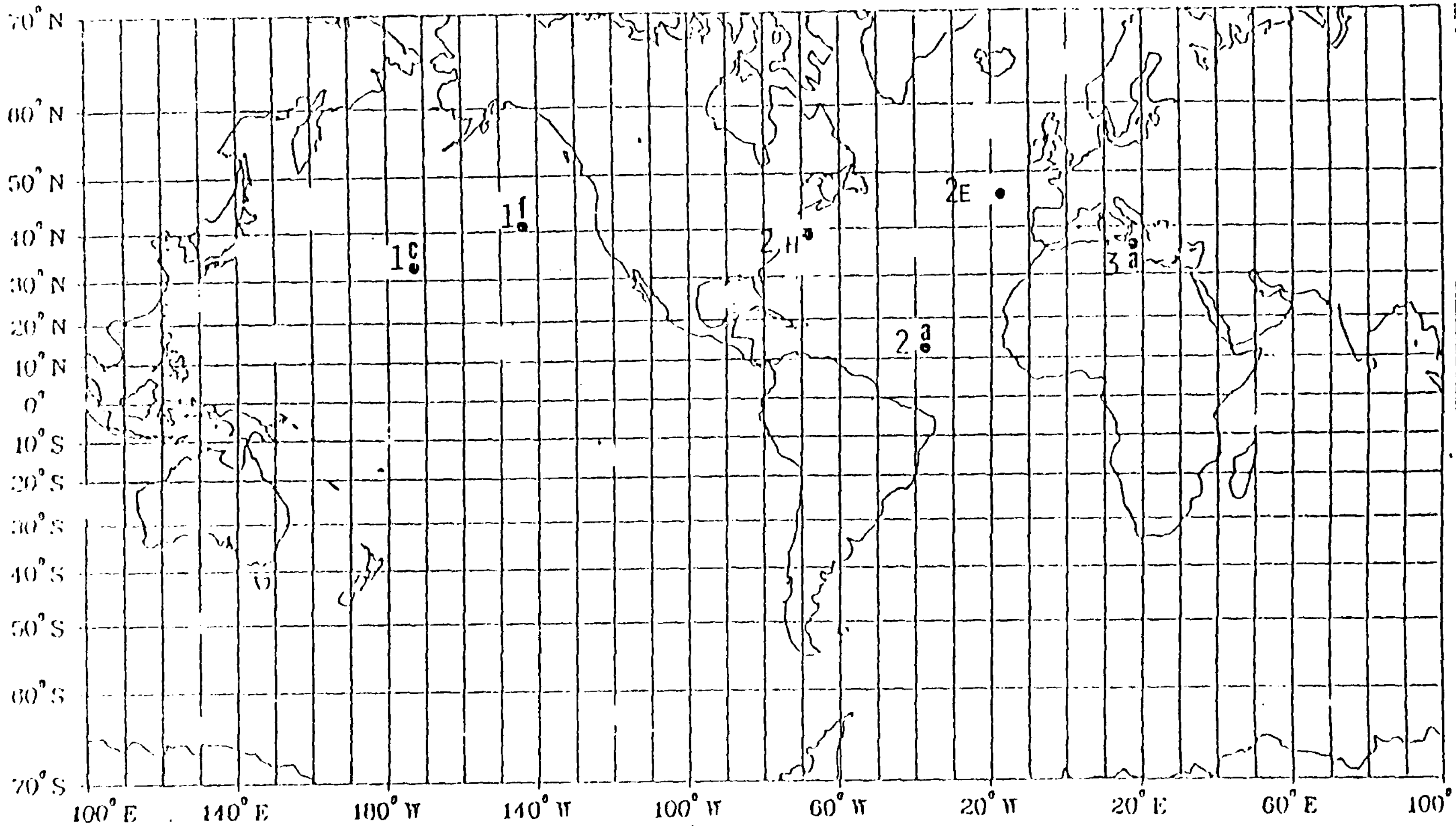


FIGURE (1)

Example of the SIMAS hand annotated inflection points using a straight edge (G. Brown)



Plot of (6) Geographic Locations

FIGURE 2

		SIMAS(S)		ICAPS(I)			
		Constant Salinity		Variable Salinity			
Site	Depth (ft)	Salinity (PPT)	Sound Speed (ft/sec)	Salinity (PPT)	Sound Speed (ft/sec)	ΔS (I-S)	ΔV (I-S)
1C	0.0	34.43	4964.8	34.41	4964.9	-0.02	0.1
	830.1		4948.5	34.33	4948.3	-0.10	-0.2
	1561.8		4911.4	34.07	4910.1	-0.36	-1.3
1F	0.0	33.66	4910.7	33.40	4910.0	-0.26	-0.7
	767.8		4885.9	33.98	4887.6	0.32	1.7
	1630.7		4852.9	33.97	4854.4	0.31	1.5
2A	0.0	36.34	5045.1	36.54	5046.1	0.20	1.0
	734.9		4948.6	36.19	4948.2	-0.15	-0.4
	1492.9		4912.8	35.33	4908.9	-1.01	-3.9
2H	0.0	33.72	4917.2	32.41	4912.2	-1.31	-5.0
	807.1		4920.3	34.76	4924.8	1.04	4.5
	1656.9		4873.4	34.91	4878.8	1.19	5.4

TABLE I: CONSTANT VERSUS VARIABLE SALINITY EFFECTS ON SOUND SPEED PROFILES (ODSI)

Site	Salinity ($\bar{S}_{500}$) (PPT)	SIMAS Data Base Salinity (S) (PPT)	ΔS $\bar{S}_{500}$-S (PPT)	Max ΔV est. (ft/sec)
1C	34.43	35.0	-.57	-2.62
1F	33.66	35.0	-1.34	-6.16
2A	36.34	35.0	1.34	6.16
2H	33.72	35.0	-1.28	-5.89

$\bar{S}_{500}$ = Value of ICAPS Salinity at 500 feet.

TABLE II: AVERAGE VERSUS 35 PPT SALINITY EFFECTS ON SOUND SPEED (ODSI)

Table IV. **The Maximum Difference in Sound Speed Among Three Frequently Used Sound Speed Equations (U)** (TAKEN FROM MAC INC) - LETTER

Point #	Depth (ft)	Sound Velocity (F/S) Leroy	Frye & Pugh	Wilson (Rev)	Δ SVP (F/S)
1	0	5007.434	5006.395	5007.227	1.039
2	100	5009.078	5008.082	5008.871	.996
3	200	5010.719	5009.770	5010.520	.949
4	300	5011.883	5010.969	5011.680	.914
5	400	5013.043	5012.168	5012.844	.875
6	500	5012.738	5011.887	5012.543	.851
7	600	5012.422	5011.590	5012.230	.832
8	700	5012.094	5011.281	5011.906	.813
9	800	5011.754	5010.957	5011.566	.797
10	900	5011.398	5010.617	5011.215	.781
11	1000	5011.027	5010.266	5010.848	.761
12	1100	5009.746	5008.871	5009.566	.875
13	1200	5008.953	5007.996	5008.781	.957
14	1300	5008.664	5007.652	5008.492	1.012
15	1400	5007.848	5006.801	5007.676	1.047
16	1500	5007.539	5006.477	5007.367	1.062
17	1600	5005.246	5004.184	5005.078	1.062
18	1800	5002.414	5001.430	5002.258	.984
19	2000	4998.797	4997.867	4998.645	.930
20	2500	4987.629	4986.863	4987.508	.766
21	3000	4966.602	4966.023	4966.543	.579
22	3500	4933.992	4933.734	4933.996	.262
23	4000	4911.727	4911.715	4911.730	.015
24	4250	4907.180	4907.211	4907.184	.031
25	4500	4903.258	4903.320	4903.254	.066
26	4750	4901.484	4901.562	4901.480	.082
27	5000	4901.926	4902.020	4901.922	.098
28	5250	4902.355	4902.457	4902.348	.109
29	5500	4902.770	4902.875	4902.762	.113
30	5750	4905.465	4905.578	4905.461	.117
31	6000	4908.164	4908.281	4908.160	.121
32	6500	4915.109	4915.234	4915.109	.125
33	7000	4922.074	4922.215	4922.078	.141
34	8000	4936.840	4937.016	4936.855	.176
35	9000	4952.473	4952.695	4952.496	.222
36	10000	4966.656	4966.937	4966.695	.281
37	11000	4980.941	4981.289	4980.992	.348
38	12000	4996.094	4996.516	4996.160	.422
39	13000	5011.352	5011.848	5011.430	.496
40	14500	5034.816	5035.434	5034.902	.618
				Mean	.568

APPENDICIES

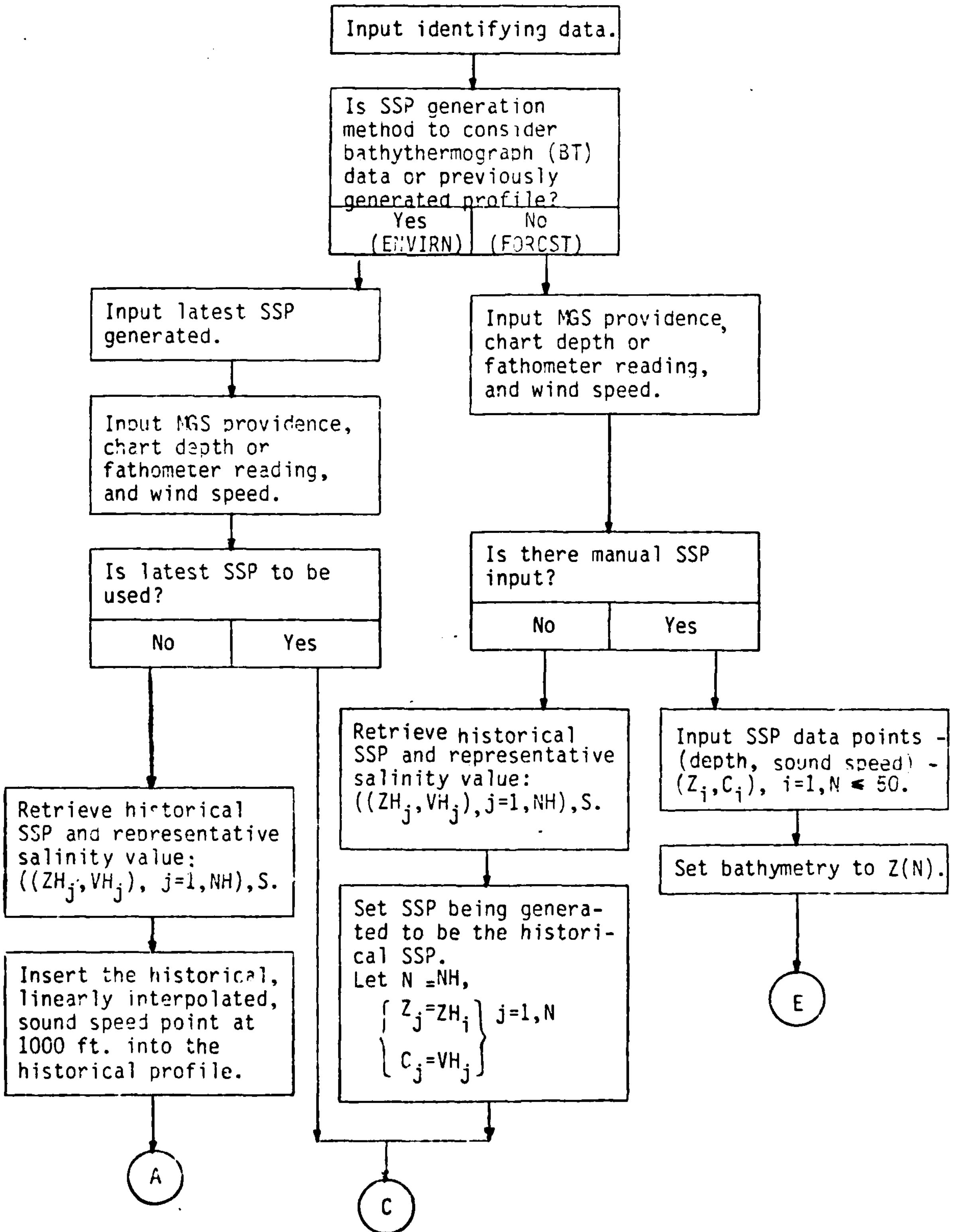
APPENDIX (A)

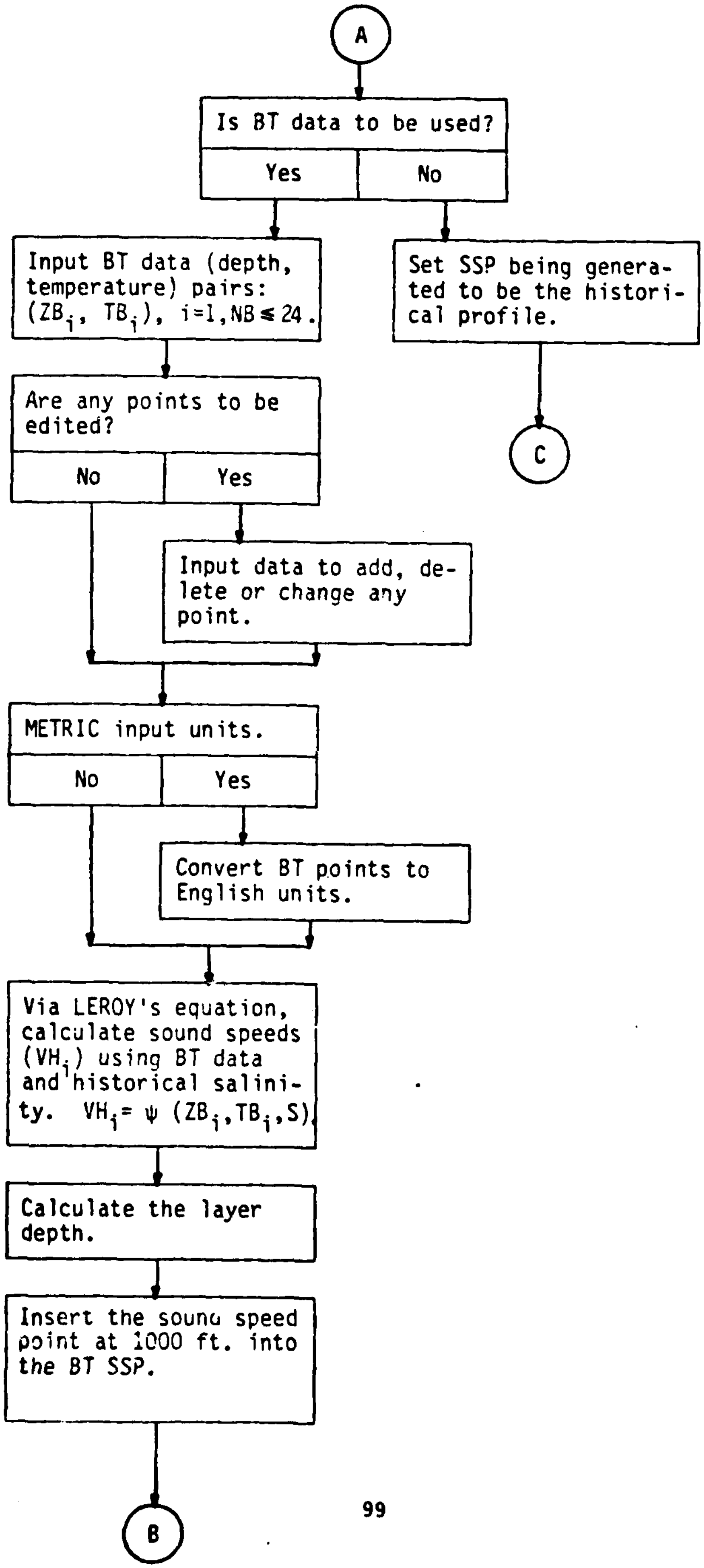
SIMAS LOGIC FLOW

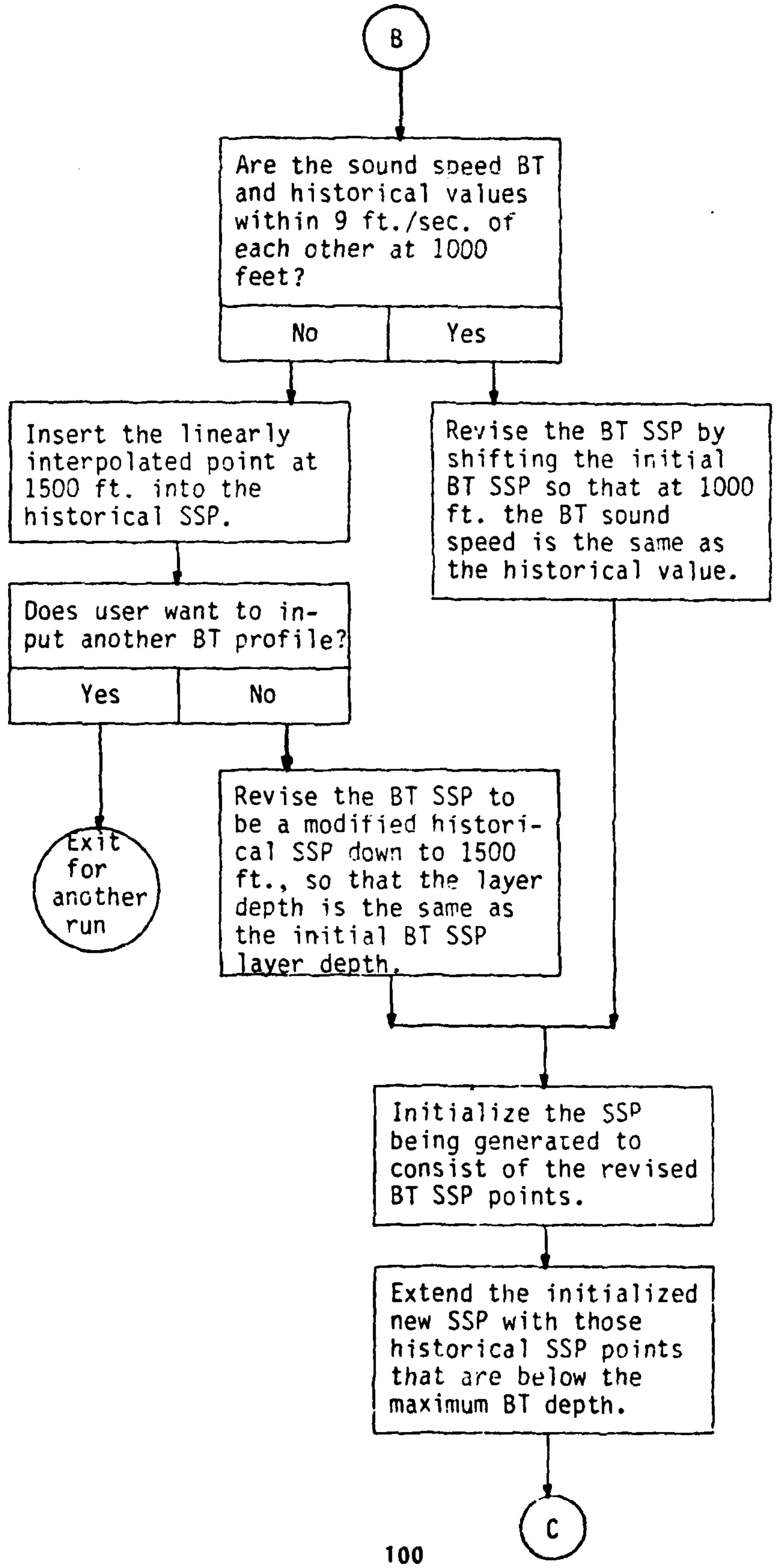
by

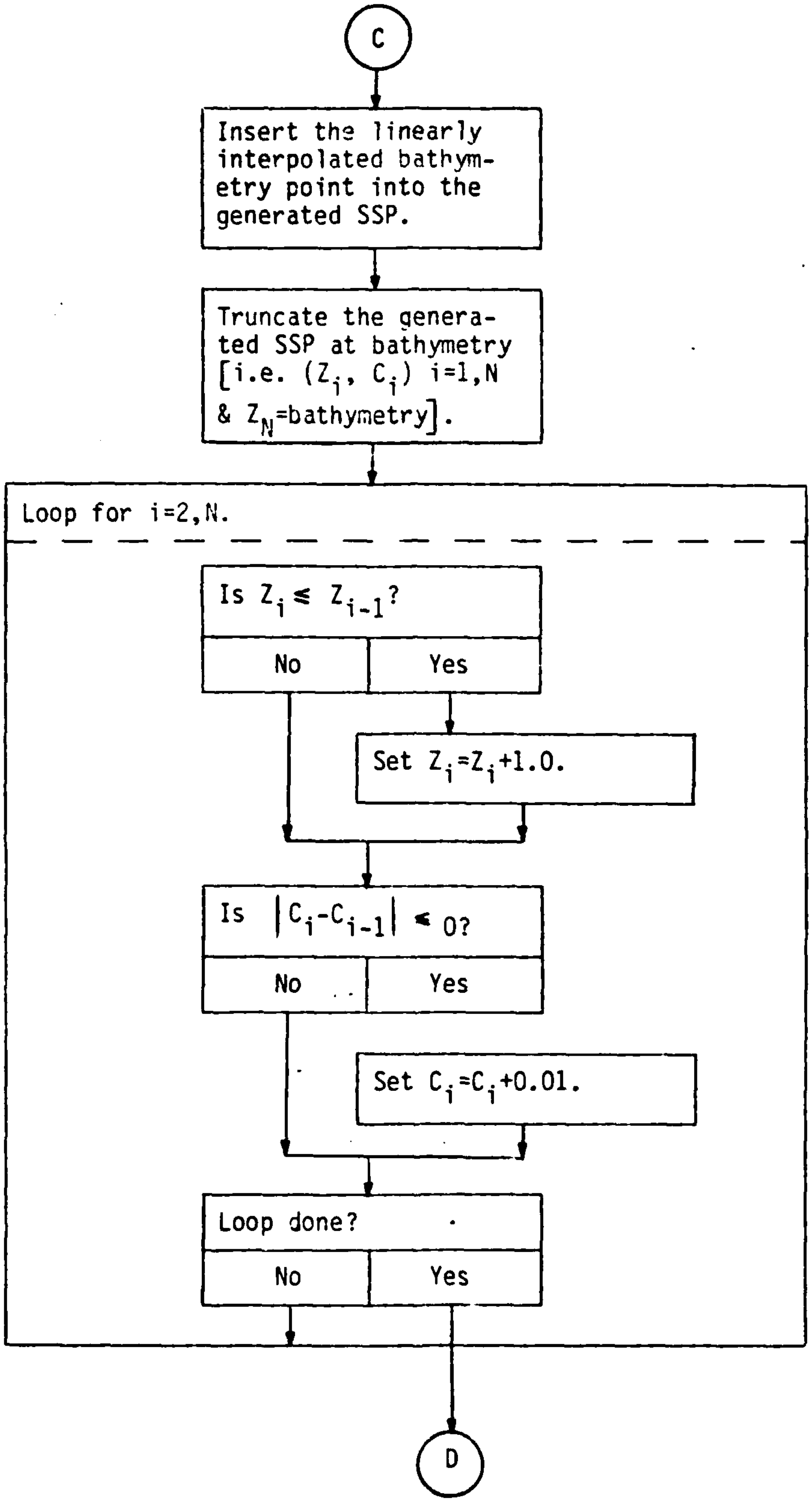
J. Locklin
and
B. Scaiffe

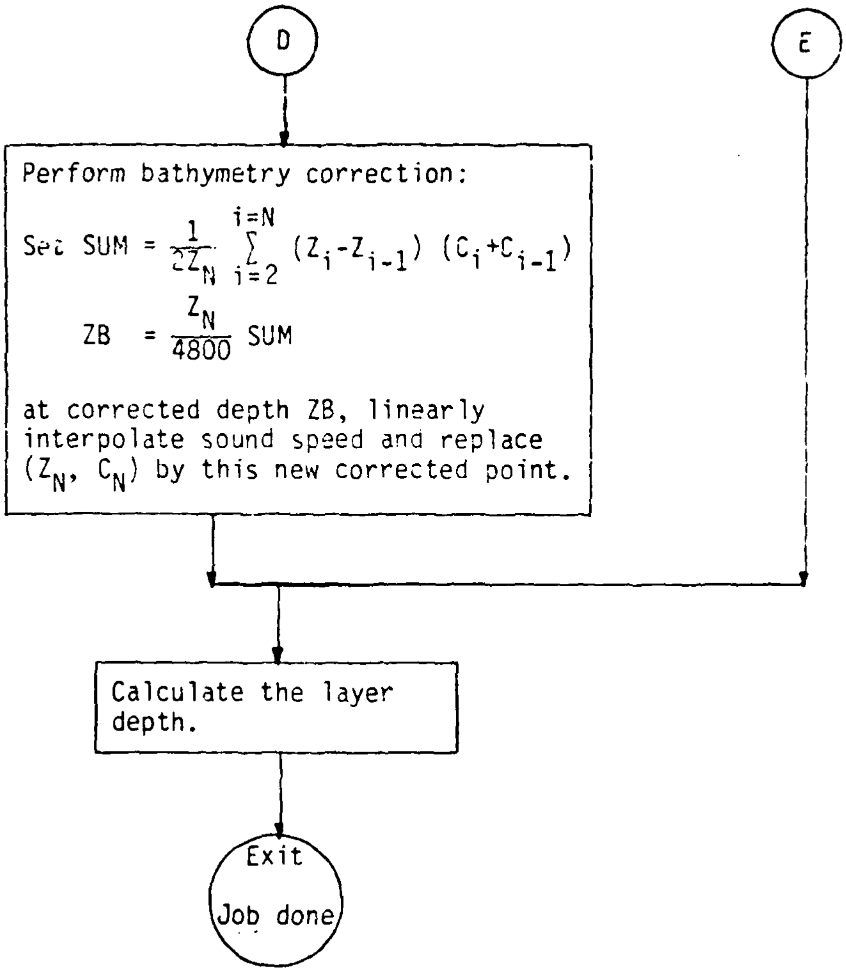
SIMAS Sound Speed Profile (SSP) Generation




A
Is BT data to be used?
Yes
No
Input BT data (depth, temperature) pairs: (ZB_i, TB_i), i=1,NB ≤ 24.
Set SSP being generated to be the historical profile.
C
Are any points to be edited?
No
Yes
Input data to add, delete or change any point.
METRIC input units.
No
Yes
Convert BT points to English units.
Via LEROY's equation, calculate sound speeds (VH_i) using BT data and historical salinity. $VH_i = \psi(ZB_i, TB_i, S)$
Calculate the layer depth.
Insert the sound speed point at 1000 ft. into the BT SSP.
B


B
Are the sound speed BT and historical values within 9 ft./sec. of each other at 1000 feet?
No
Yes
Insert the linearly interpolated point at 1500 ft. into the historical SSP.
Revise the BT SSP by shifting the initial BT SSP so that at 1000 ft. the BT sound speed is the same as the historical value.
Does user want to input another BT profile?
Yes
No
Exit for another run
Revise the BT SSP to be a modified historical SSP down to 1500 ft., so that the layer depth is the same as the initial BT SSP layer depth.
Initialize the SSP being generated to consist of the revised BT SSP points.
Extend the initialized new SSP with those historical SSP points that are below the maximum BT depth.
C


C
Insert the linearly interpolated bathymetry point into the generated SSP.
Truncate the generated SSP at bathymetry [i.e. (Z_i, C_i) i=1,N & Z_N=bathymetry].
Loop for i=2,N.
Is $Z_i \leq Z_{i-1}$?
No
Yes
Set $Z_i=Z_i+1.0$.
Is $|C_i-C_{i-1}| \leq 0$?
No
Yes
Set $C_i=C_i+0.01$.
Loop done?
No
Yes
D


D
E
Perform bathymetry correction:
Set $SUM = \frac{1}{2Z_N} \sum_{i=2}^{i=N} (Z_i - Z_{i-1}) (C_i + C_{i-1})$
$ZB = \frac{Z_N}{4800} SUM$
at corrected depth ZB, linearly interpolate sound speed and replace (Z_N, C_N) by this new corrected point.
Calculate the layer depth.
Exit
Job done

APPENDIX (B)

ICAPS LOGIC FLOW

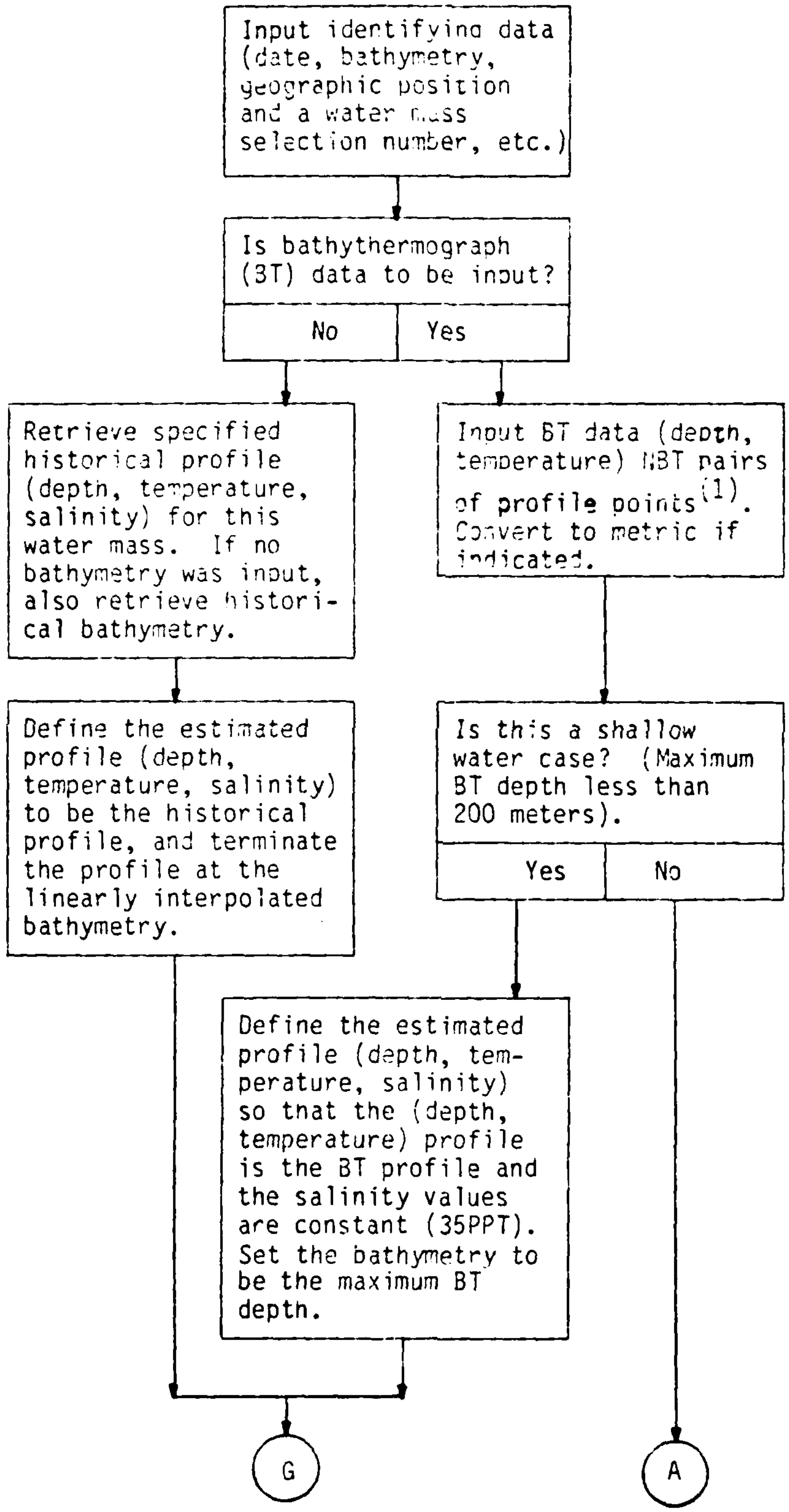
by

J. Locklin

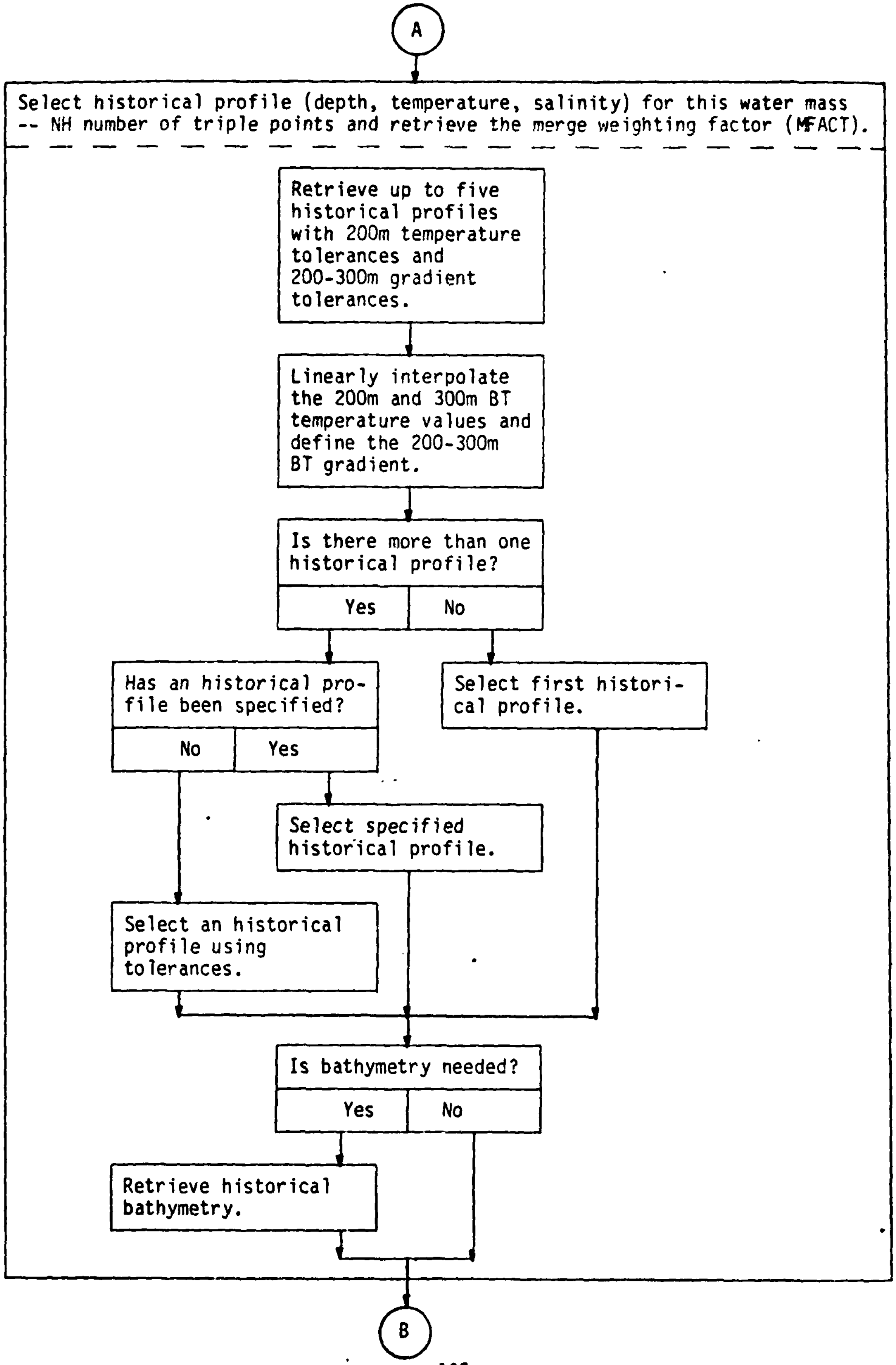
and

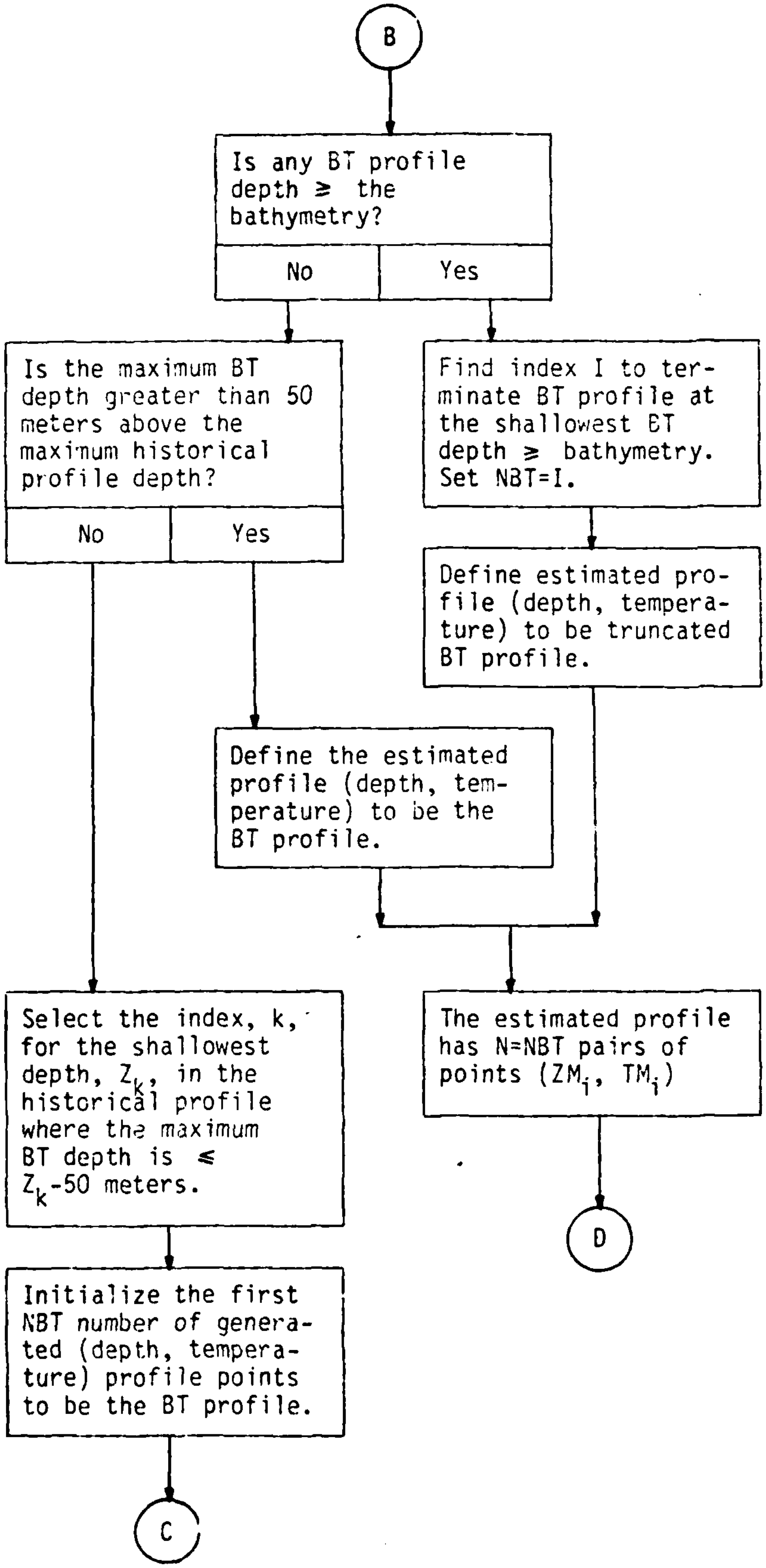
B. Scaiffe

ICAPS Sound Speed Profile (SSP) Generation (UNIVAC Version)



(1) NBT $\leq \begin{Bmatrix} 16 \text{ Univac} \\ 30 \text{ Nova} \end{Bmatrix}$


A
Select historical profile (depth, temperature, salinity) for this water mass -- NH number of triple points and retrieve the merge weighting factor (MFACT).
Retrieve up to five historical profiles with 200m temperature tolerances and 200-300m gradient tolerances.
Linearly interpolate the 200m and 300m BT temperature values and define the 200-300m BT gradient.
Is there more than one historical profile?
Yes
No
Has an historical profile been specified?
No
Yes
Select first historical profile.
Select specified historical profile.
Select an historical profile using tolerances.
Is bathymetry needed?
Yes
No
Retrieve historical bathymetry.
B


B
Is any BT profile depth ≥ the bathymetry?
No
Yes
Is the maximum BT depth greater than 50 meters above the maximum historical profile depth?
No
Yes
Find index I to terminate BT profile at the shallowest BT depth ≥ bathymetry. Set NBT=I.
Define estimated profile (depth, temperature) to be truncated BT profile.
Define the estimated profile (depth, temperature) to be the BT profile.
Select the index, k, for the shallowest depth, Z_k, in the historical profile where the maximum BT depth is ≤ Z_k-50 meters.
The estimated profile has N=NBT pairs of points (ZM_i, TM_i)
Initialize the first NBT number of generated (depth, temperature) profile points to be the BT profile.
C
D

C

Complete the (depth, temperature) profile being generated by augmenting the initialized NBT number of points with the historical depths Z_i for i=k,...,NH and modify the associated historical temperatures, T_i.

Let (ZM_j, TM_j), j=1, N be the initialized generated profile points (N=NBT).

Calculate $\Delta T = TM_N - T_{k-1} + \frac{(T_k - T_{k-1})(ZM_N - Z_{k-1})}{(Z_k - Z_{k-1})}$

X=MFACT/1000.

Loop over historical profile for i=k,...NH

Calculate N =N+1

$ZM_N = Z_i$

$\Delta T = (\Delta T) X^{(Z_i - Z_{i-1})/100.}$

$TM_N = T_i + \Delta T$

Is the depth, ZM_N, less than the bathymetry?

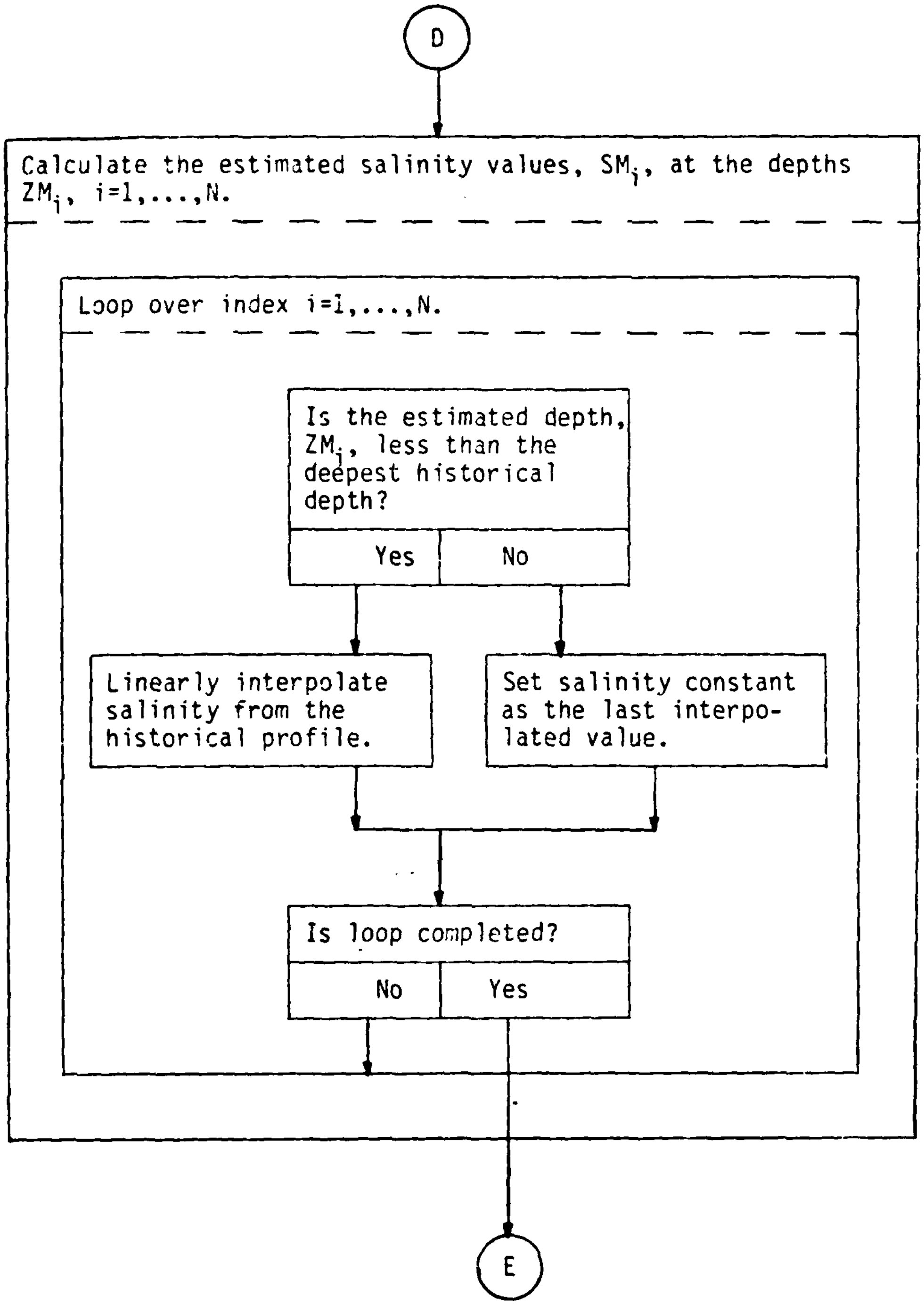
Yes | No

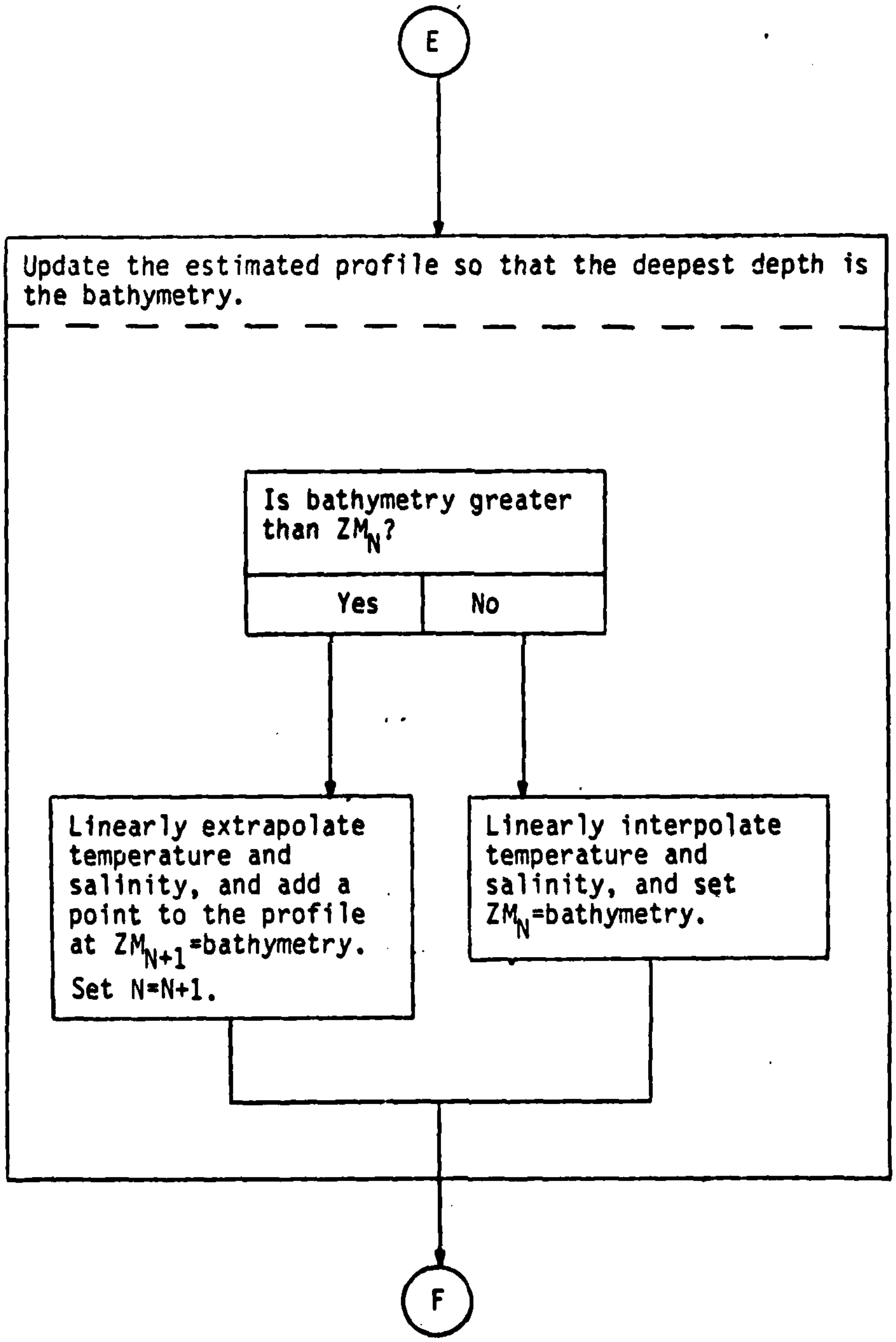
Is loop completed?

No | Yes

The estimated profile now has N pairs of points

D


D
Calculate the estimated salinity values, SM_i, at the depths ZM_i, i=1,...,N.
Loop over index i=1,...,N.
Is the estimated depth, ZM_i, less than the deepest historical depth?
Yes
No
Linearly interpolate salinity from the historical profile.
Set salinity constant as the last interpolated value.
Is loop completed?
No
Yes
E


E
Update the estimated profile so that the deepest depth is the bathymetry.
Is bathymetry greater than ZM_N?
Yes
No
Linearly extrapolate temperature and salinity, and add a point to the profile at ZM_{N+1}=bathymetry.
Set N=N+1.
Linearly interpolate temperature and salinity, and set ZM_N=bathymetry.
F

(F)

Correct the estimated salinity values for stability.

Calculate the densities by the density function $\sigma_{T_i}(TM_i, SM_i)$, for $i=1,\ldots,N$.

Loop over $j=1,N-1$.

Set $i=N-j$.

Is σ_{T_i} greater than $\sigma_{T_{i+1}}$?

Yes	No

Set $\Delta\sigma_T = \sigma_{T_{i+1}} - \sigma_{T_i}$

$$\Delta S = \frac{\Delta\sigma_T - 0.01}{.7714 + (1.69)10^{-7} SM_i^3}$$

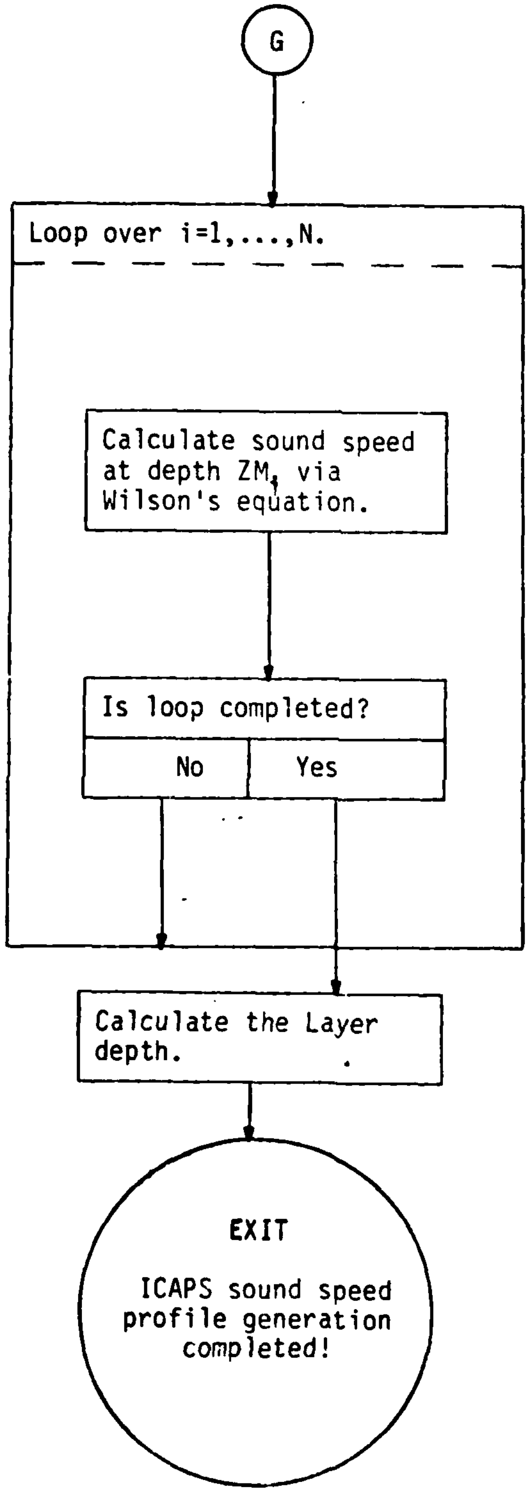
$SM_i = SM_i + \Delta S$

Recalculate σ_{T_i}.

Is loop completed?

No	Yes

(G)


G
Loop over i=1,...,N.
Calculate sound speed at depth ZM, via Wilson's equation.
Is loop completed?
No
Yes
Calculate the Layer depth.
EXIT
ICAPS sound speed profile generation completed!

APPENDIX (C)

2. SIMAS

2.1 PROGRAM ERRORS

2.1.1 Conversion errors occur involving subroutines BT and EDITBT. Metric inputs are converted to English units at least twice. We understand that this is corrected at NUSC but not at NORDA.

2.1.2 Subroutine CKBT shows an error in the algorithm for modifying the historical data to reflect the BT profile layer depth. The DO loop at FORTRAN statement number 550 may be executed with K=N15+1, i.e.

```
DO 600 J=N15+1,N15
```

thus causing erroneoud results.

APPENDIX (D)

1. ICAPS

1.1 PROGRAM ERRORS

1.1.1 Univac Version

1.1.1.1 The synthesized profile contains salinities that are initialized by interpolating values from the historical profile, and when a depth of the synthesized profile is equal to or exceeds the maximum depth of the historical profile (a most frequent occurrence) the salinity is set to be the historical salinity for the previous depth. This can be corrected by changing the inequality ".LT." to ".LE." in the IF statement following FORTRAN statement number 50 in subroutine MERGE. This code error will have negligable impact for the deeper profiles. For shallower profiles the impact will depend upon the effect on velocity by the error in salinity.

1.1.1.2 When the user wishes to use only the historical data (no BT data: NDP=0 and BOTZ 1.0) and metric is not specified (MOE ≠ "M"), the program incorrectly multiplies the historical bathymetry in meters by the feet-to-meters conversion factor, FTMT. This can be corrected by inserting after format statement number 9001 in the main program

IF (MOE .NE. 1 HM) BOTZ = FTMT*BOTZ

and deleting the statement immediately after FORTRAN statement number 10, and replacing FORTRAN statement number 100 with

100 CONTINUE.

1.1.1.3 An error message is not utilized when appropriate and an incorrect message is printed. Change the line just preceeding format statement number 1045 to read

WRITE (6, 1045) IBTYP2.

1.1.1.4 In the main program, there is an "MP" variable occurring just after format statement number 1013 that is not initialized. Apparently, this was to have been defined by "NP" in the preceeding call to subroutine COMPUX. This is corrected by changing "NP" to "MP," the last argument in the argument list for the "CALL COMPUX ..." statement, two lines after FORTRAN statement number 360.

1.1.1.5 Subroutine MERGE calls subroutine SGMTST to perform the water column stability algorithm from the bottom of the merged profile. Though this is in contrast with the NOVA version that starts from the bottom of the BT, it is more reasonable since the algorithm is applied just below the BT where merging occurs (refer to paragraph 1.1.2.2). Subroutine SGMTST has an incorrect DIMENSION statement allocating insufficient memory, particularly for the density array. The current dimension for 30 elements is not consistent with the calling routine. The arrays should be dimensioned for 50 elements each, since the calling routine, MERGE, identifies the arrays as for the merged profile. This is corrected by changing the dimension statement in subroutine SGMTST to read

DIMENSION T(50), S(50), SIGMA(50)

1.1.1.6 Under normal operating system usage, the density and stability calculations will be incorrect. Mixed expressions contain integers raised to negative integer powers which result in zero values.

1.1.1.6.1 Subroutine SIGMAT has an equation "B = ..." that contains the integer 10 raised to a negative integer power.

1.1.1.6.2 Subroutine SGMTST has the equation "DS = ..." that contains two integer 10's raised to negative powers.

1.1.2 Nova 800 version

1.1.2.1 Same error as described in paragraph 1.1.1.1 above.

1.1.2.2 The program should perform the water column stability algorithm from the bottom of the merged profile as the Univac version does (refer to paragraph 1.1.1.5) — rather than from the bottom fo the BT. Thus, the effects on density (refer to paragraph 1.3.4.2) due to temperature revisions by merging just below the deepest BT depth would be accounted for. This can be corrected by changing in subroutine MERGE, the FORTRAN statement just after statement number 100 to:

N=NOPTM-1

and two lines later, change to read

K=NOPTM-J.

2.2 PROGRAM CAUTIONS (SIMAS)

2.2.1 The generated SSP arrays are allocated for 50 points. Subroutine INSERT adds points to the generated profile, and subroutine ENVIRN extends the up to 25 revised BT profile points with historical points. The program does not properly check on this limit. Structurally, depth array element Z(51) is the location of velocity C(1), the surface velocity which could be changed to be the Z(51) value.

2.2.2 Subroutine BT can input up to 25 BT temperature profile points. Subroutine CKBT calls subroutine INSERT to augment the BT points with the interpolated temperature point at 1000 feet, whenever the *input BT profile* does not have a 1000 ft. point. Since the program allocates space for 25 BT points, an overflow can occur, so that the surface temperature, T(1), value is replaced by the overflow depth value, D(26).

2.2.3 Whenever the BT profile is augmented by a point at 1000 ft., extrapolation is performed when the profile is to be extended by a 1000 ft. point. The SIMAS program also does not consider the reasonability of the extrapolation, see paragraph 1.2.1.2 above.

2.2.4 In subroutines ENVIRN and FORCST, there is no test that the corrected bottom depth value is in the deepest (last) interval which ends with the input fathometer (or chart) value. Consequently, extrapolation may occur.

2.3 COMMENTS — The methodology is to shift the BT SSP so that at 1000 feet the shifted BT SSP has the same velocity value as does the historical profile. The shifted BT SSP is then extended by those historical profile points below the deepest BT SSP depth.

2.3.1 SIMAS assumes that the historical profile will <u>always</u> extend below the BT profile. This assumption can only be valid <u>if</u>, over each geographical area, the associated historical profile extends down to the deepest bathymetry in the area, and any deepest BT depth value would not be deeper due to measurement errors. Though the assumption will usually be valid, it is too strict for a general *purpose production program.* Since the program does not verify the input data to meet this assumption, errored profiles may result (refer to subroutine ENVIRN lines 0052 through 0063).

2.3.2 The criteria at 1000 feet does not assure a smooth transition below that depth from the bottom of the shifted BT profile and the attached historical points.

2.3.3 Assuming that the usage of the layer depth is important, a comment on the SIMAS layer depth algorithm is appropriate. Subroutine LAYER defines the layer depth to be the shallowest depth after which the velocity gradient first becomes negative. This algorithm requires that the BT data not be noisy, and it consists of points that only define the <u>essential</u> shape of the profile.

APPENDIX (F)

1.2 PROGRAM CAUTIONS

1.2.1 ICAPS, Univac and Nova versions

1.2.1.1 When a merged profile is created, the number of points defining the profile is not verified to avoid exceeding the allocated storage for a maximum of 50 points. In the event that a merged profile should have more than 50 points, the overflow would incorrectly redefine necessary program locations (e.g. the near-surface temperatures, TM(1), TM(2), ..., would be redefined by depth values ZM(51), ZM(52), ..., respectively, etc.)

1.2.1.2 When the bathymetry is below the ICAPS merged profile, the merged profile is augmented by one more point defined by the bathymetry, and temperature and salinity values extrapolated from the deepest (last) depth interval in the profile. The ICAPS program does not address the question "How reasonable are the extrapolated values?". Reasonability of these values is dependent upon how much deeper the extrapolation extends the profile with respect to the depth interval being extrapolated from, and the gradient on that same interval.

1.3 COMMENTS — ICAPS is a merge methodology that assumes the bathythermograph, BT, data is the best current information upon which to define a sound speed profile (SSP); and, the historical data extending below the BT profile is the most reasonable information available to merge with the BT data to form representative up-to-date SSP.

1.3.1 A shallow water case is defined when the deepest depth of the input BT data is above 200m. This excludes a merge with historical data -- e.g. an operator cannot input a shallow BT profile to merge with historical data for a deeper water mass. In shallow areas where BT data is sufficient, a shallow water case should be specified by another input parameter, rather than the deepest BT profile depth.

1.3.2 For a shallow water case, the salinity is set to 35 PPT. This is considered valid everywhere except in the Mediterranean Sea where 38 PPT is more appropriate. In keeping with the philosophy of making use of the "best" information available, historical data (salinity) should still be utilized whenever it's available.

1.3.3 Coding of constants is more efficient when using the form ±X.XXE±YY, rather than ±X.XX*10.**(-YY) (see subroutines SGMTST and SIGMAT).

1.3.4 There are inconsistencies between the ICAPS program and the reference report, "The ICAPS Water Mass History File," by Alvan Fisher, Jr., May 1978.

1.3.4.1 The program implementation of the synthesized temperature algorithm (see Enclosure 5), is reasonable, though the approximation to the synthesizing algorithm is unnecessary.

1.3.4.2 The density (sigma-t) stability algorithm described in Appendix A (reference (1)) does not correspond to the implementation. The document states, "... salinity inversion must coincide with a temperature inversion ...". The code assumes that if the density at depth Z_j is greater than the density at the depth below, Z_{j+1}, (starting from the bottom of the profile), then recompute the salinity at Z_j via the stability expression and use this "corrected" salinity value with the temperature to recalculate the density at depth Z_j. There is no application of the criteria to adjust salinities that are "... *within* temperature inversions that are more than the temperature maximum minus 0.25°C at the lower boundary of the inversion ..." One should note that the stability expression was derived for a constant temperature of 10°C and salinity ranges of 30 to 40 PPT. This algorithm to "correct" salinity is applied whenever the density does not monotonically increase with depth, and over the temperature ranges of the BT. The BT temperatures can range from approximately 4°C on up to 27°C. This wide range of temperatures suggests a temperature varying stability algorithm --e.g. at depth Z_j, adjust the historical salinity by the increment indicated by the change in temperature (merge temperature minus historical temperature) to stabilize the water column at depth Z_j --.

1.3.5 Both program versions retrieve a historical profile as described in the report "Description of ICAPS Environmental Data Structure" by John Lever, NAVOCEANO TN 3700-82-79, March 1979. The report presents the file structure and the retrieval algorithm. The following comments may enable the report to be more useful; particularly for profile revisions.

1.3.5.1 Expand the text to specifically define the ordering of profiles (water masses) for a geographical location. Although the ordering is intrinsic to the retrieval design (refer to report figure 6), the following conditions being stated would clarify the profile data:

When more than one water mass represent a geographical location, let $1<N\leq 5$ be the number of profiles, then XMINT2(i), XMAXT2(i), i=1, N must be defined (temperature tolerances at 200m), and

1) XMINT2(i)<XMAXT2(i) for i=1, N
2) XMINT2(i) = XMAXT2(i-1) for i=2, N

must be true for continuity. The exception to this is that two adjacent profiles can have the same tolerances, XMINT2(j) = XMINT2(j+1) and XMAXT2(j) = XMAXT2(j+1). For this exception, there must be a non-zero flag (NOGL(j)) in order to consider the j+1 profile. The tie breaker is the 200-300m gradient tolerances (XMINGL(j), XMAXGL(j)) and (XMINGL(j+1), XMAXGL(j+1)). When NOGL(j) is non-zero, then XMINGL(j) and XMAXGL(j) must be defined. Profile j is selected for the BT temperature gradient less than XMAXGL(j), otherwise profile j+1 is selected. If the gradient tolerances are given for j+1, then XMAXGL(j) = XMINGL(j+1) must occur for continuity. In practice, the tolerances at j+1 are only necessary to make an output message meaningful when the BT gradient at 200-300m is greater than XMAXGL(j+1).

1.3.5.2 On pages 3 and 9, state that the maximum number of points for a historical profile is 45.

1.3.5.3 On pages 10 and 11, the references labelled "400" should be labelled "80" in order to agree with the programs, as do the other labelled references.

1.3.5.4 On page 3, line 2 of the second paragraph, "NOPTS(N)" should be "NOPTI(N)" since NOPTS is set to the NOPTI(I) value for the selected profile.

1.3.5 On page 3, the text should state that $NPRF\leq 5$.

APPENDIX (G)

SYNTHETIC BATHYMETRIC PROFILING SYSTEM (SYNBAPS)

BY

MR. ROGER VANWYCKHOUSE

(NAVAL OCEAN RESEARCH AND DEVELOPMENT ACTIVITY)

Synthetic Bathymetric Profiling System

by

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Ocean Acoustics Division
Naval Oceanographic Laboratory
Naval Ocean Research and Development Activity

The Synthetic Bathymetric Profiling System (SYNBAPS) is a combination of digital computer software (programs) and a random-access storage file of gridded bathymetric data, employed to rapidly generate random, great-circle, bathymetric profiles suitable for acoustic propagation modeling. SYNBAPS is completely automatic, requiring only the input, via a control card, of the latitude and longitude of the beginning point, the bearing, and the maximum range or the locations of the beginning and end points. The generated profile is available in two forms. The first is a computer drawn profile where range in whole nautical miles is plotted against depth, in either meters, fathoms, or feet; the second is a card image file of the same data. The profile outputs in the card image file are available on magnetic tape, punched cards or listing. Single depth point retrieval is another feature of the system.

The need for a computerized bathymetric data bank and techniques for rapidly manipulating large quantities of data became evident as demand for bathymetric profiles increased and became more urgent. It became increasingly difficult to satisfy these demands through manual compilation of depth soundings, contouring, and profile constructions. A massive recompilation and reanalysis of bathymetric data, systematic revision of all bathymetric charts in the North Atlantic and North Pacific Oceans, including extension of chart coverage to the equator, was recently completed. The impracticality of using the existing official data bank of bathymetric soundings for machine generation of profiles became apparent. The need for a specialized bathymetric data bank to support acoustic - oceanographic modeling gave rise to development of a synthetic bathymetric profiling project using the new bathymetric contour charts as the data base. The project developed procedures for digitizing the contour charts, and computer programs and subroutines for data storage and retrieval and for profile generation.

The SYNBAPS data base was designed to meet the specific and immediate need for bathymetric profiles for acoustic modeling. However, properly used, the data base offers a myriad of applications beyond its preliminary design. The coverage of the data base is shown in figure 1.

Often in naval planning as well as in naval operations, speed is as important as accuracy when information is needed. SYNBAPS is not ideally suited to hydrographic charting because some high resolution detail is lost, but it provides very rapid responses. SYNBAPS has these additional features:

- Only gridded depth points are stored in the data bank (3,489,066 points),
- The locations of the depth points are logically structured on a Mercator projection by 5-longitudinal minutes/5-meridianal part intersections,
- Random access to the data is by large blocks (691 five-degree squares),
- The data bank is updated by replacing the blocks of data,
- The size of the data bank is fixed once it has been created for an ocean area,
- Rapid contouring of five-degree squares of data for inspection or editing can be done directly for the Mercator projection, the most commonly used projection for bathymetric charts,
- Classified survey data, in chart form, can be incorporated in the data base with no compromise of security, the present data base is unclassified,
- Highly compacted forms of the accessing program and the data base can be used on shipboard or other platforms,
- Subsets of the data base can be used in other model data bases requiring bathymetry (a derivative of SYNBAPS with 1/6° resolution is being used in the Automated Signal Excess Prediction System (ASEPS) Data Base),
- The data base is available on one 9 track, 1600 bpi, EBCDIC code magnetic tape,
- The data base, a profile accessing program and an editing program are fully documented and provided with the system,
- In addition to the documentation provided with the data base the following references are available;

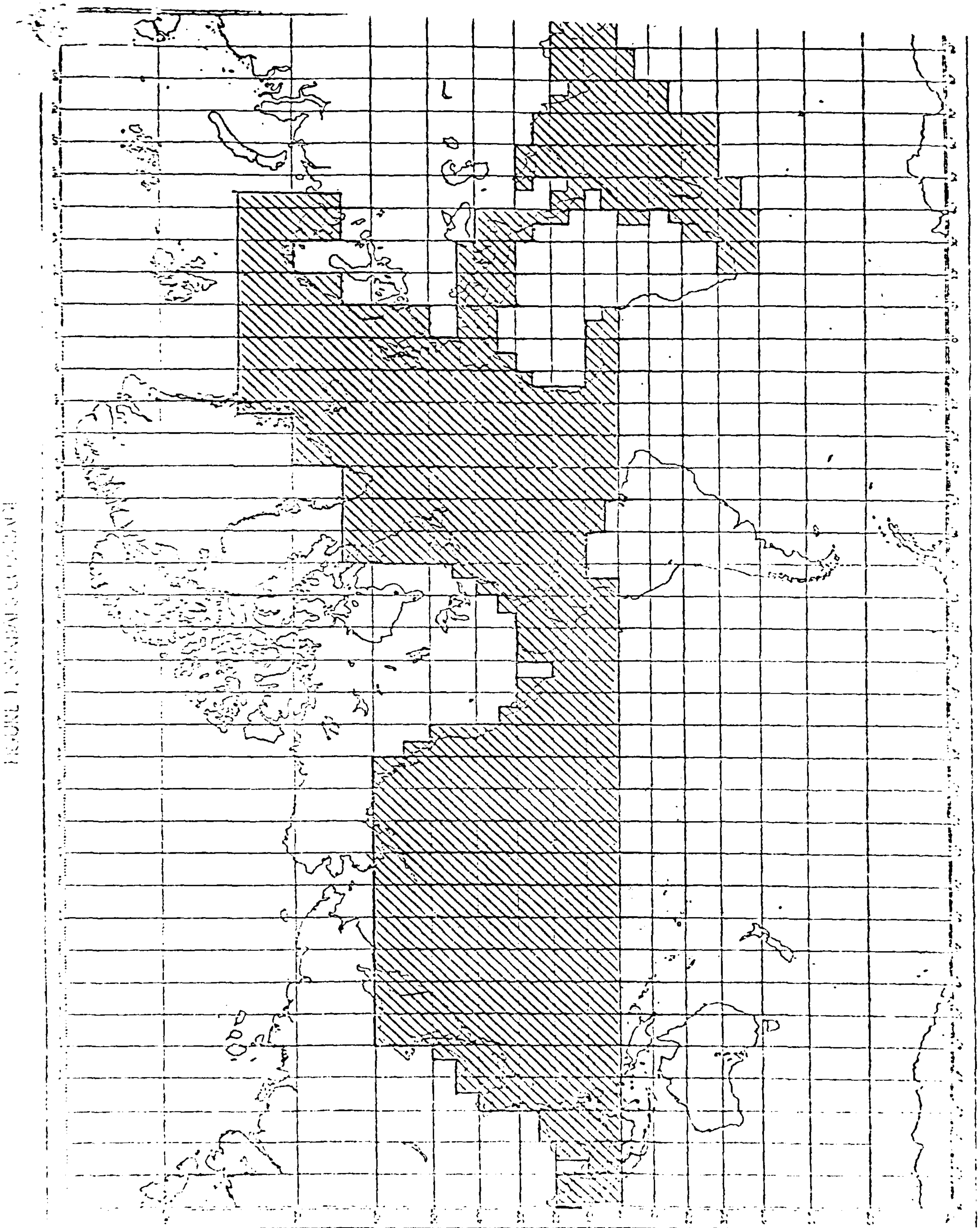

FIGURE 1. SYNBAPS COVERAGE

APPENDIX (H)

GENERALIZED DIGITAL ENVIRONMENTAL MODEL (GDEM)

BY

DR. T. DAVIS (NAVAL OCEANOGRAPHIC OFFICE)

PSR Report 922

EVALUATION OF STANDARD OCEAN CANDIDATES

J. G. Colborn
S. C. Daubin, Jr.
E. Hashimoto
E. J. Ryan

March 1980

Final Technical Report
Contract N00014-79-C-0310

Sponsored by
Long-Range Acoustic Propagation Project
Naval Ocean Research and Development Activity
NSTL Station, Bay St. Louis, Mississippi 39529

PACIFIC•SIERRA RESEARCH CORP.

Overview

"This report describes and evaluates eight existing or proposed oceanographic models as candidates for Standard Ocean, a data retrieval system to be installed in the Long Range Acoustic Propagation Project (LRAPP) data bank. The primary purpose of Standard Ocean is to provide range-dependent sound-speed profiles for input to NORDA's numerical acoustic models. Standard Ocean will also be used to support the objective analysis of environmental data collected during exercises at sea. The candidate systems and their parent organization are as follows:

AUTO-OCEAN (NORDA)	GFDL (Geophysical Fluid Dynamics Laboratory, NOAA, Princeton University)
FIB/EOTS/EXTRA (FNWC)	
GDEM (NAVOCEANO)	HYDAT (FNWC)
ICAPS (NAVOCEANO)	SIMAS (NUSC/New London)
ODSI (Ocean Data Systems, Inc.)	

The Standard Ocean Evaluation Group assessed each candidate according to criteria indicated in the following description of desired Standard Ocean capabilities. Standard Ocean is to provide accurate, realistic, and seasonal (preferably monthly) surface-to-bottom profiles of sound speed, temperature, and salinity in each oceanic $1^{\circ} \times 1^{\circ}$ square. The sound-speed profiles should be in a format suitable for numerical acoustic models. The profiles should accurately reproduce all acoustically significant features. The degree of oceanic variability in each square should be indicated. Standard Ocean should operate rapidly and inexpensively; it should be easily usable by the nonspecialist. Finally, the candidate chosen should be competitive in acquisition cost and availability."

Generalized Digital Environmental Model (GDEM) by Dr. T. Davis, NOO

"GDEM is an objective-analysis program that produces fields of analyzed temperature, salinity, and sound speed on a 30'x30' grid over various depth ranges.* Preliminary analysis has been completed for the North Pacific and Mediterranean and is beginning for the North Atlantic. The Indian Ocean segment is to be completed sometime in the future. Observational data are insufficient to run GDEM in the southern hemisphere.

The GDEM component for the upper layer models seasonal temperature between the surface and the merge depth (400m),+ annual salinity between the surface and either 400m in the Mediterranean or 800m in the Pacific, and seasonal sound speed from the surface to the merge depth in both oceans. The sound speed is derived from the analyzed temperature, salinity fields.

Below the surface models of temperature, salinity, and sound speed, there is a middepth, two-season (winter-summer) sound-speed model from 200m to 2450m. It is being augmented in the North Atlantic by a mid-depth temperature and salinity model.

The lowest component is an annual sound-speed model extending from 2000m to the bottom. There is no evidence that the developer intends to replace this model with a temperature or salinity model in the near future.

Of all Standard Ocean candidates using objective-analysis techniques, GDEM comes closest to reproducing the significant features in vertical sound-speed profiles. Comparison of model profiles with typical observed profiles

---

*This model has received our most detailed scrutiny to date.

+Merge depth, a variable peculiar to each ocean basin, is the depth at which two adjacent layers of the model are merged. In the early 1979 version of the model for the North Pacific, for example, that depth was fixed for the entire basin at 400m. We understand that the latest versions of the model adjust merge depth over the basin to fit the observed data.

for the North Pacific showed that GDEM maintains horizontal continuity yet preserves frontal structure in some cases. It appears to work well in areas with sparse data except the southern hemisphere. The 30'x30' grid spacing is the smallest of any model yet evaluated. Operation is rapid (3 min to edit an entire tape for one season in the North Pacific) and reported to be simple."

Model	Temperature	Salinity	Sound Speed	Coverage
GDEM	Seasonal, 30'x30', surface to 400m at standard depths monthly also available	Annual, 30'x30', surface to 800m at standard depths seasonal also available	Spatial resolution, 30'x30'. Temporal resolution (3 models): (1) seasonal, 0-400m, (2) 2 seasons, 200-2450m, (3) annual, 2000 m-bottom monthly also available	Mediterranean, N. Pacific, North Atlantic

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This report consists of two major parts. Each part addresses different problems or issues. Part I is titled, "Comparison of "on-board" In-situ Vertical Sound Speed Profiles from the SIMAS and ICAPS Enviromnental Data Bases with High Quality CTD and STD Data" APP FY-80 Task #I. The purpose of Part I was to compare the SIMAS and ICAPS sound speed profiles with sound speed profiles from assumed oceanography (CTD or STD observations).

Part II is titled, "Evaluation of the SIMAS and ICAPS Environmental Data Bases

Data Handling Procedures, and Merge Methodology," APP FY-80 Task #II. The purplse of PART II was to compare and recommend the data bases, algorithms, merge techniques of either SIMAS or ICAPS. The major causes for the "significant" differences in the SIMAS vs. ICAPS sound speed comparisons were found to be in the merge methodologies and historical environmental profiles.

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